Illinois EcoWatch

Technical Notes for

ForestWatch, RiparianWatch, PrairieWatch and WetlandWatch

prepared by

Mark W. Schwartz

Robert B. Blair

Mark Pyron

Kelly E. Lyons

Center for Biodiversity
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Center for Biodiversity
Illinois Natural History Survey
607 E. Peabody Drive
Champaign, IL 61820

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Authors:

Mark W. Schwartz
Center for Population Biology
University of California
Davis, CA 95616
mwschwartz@ucdavis.edu

Robert B. Blair
Department of Zoology
Miami University
Oxford, OH 45056
blairb@muohio.edu

Mark Pyron
Center for Biodiversity
Illinois Natural History Survey
Champaign, IL 61820
pyron@uiuc.edu

Kelly Lyons
Graduate Group in Ecology
University of California
Davis, CA 95616
kelyons@ucdavis.edu

Contributors:

Michael Jeffords	Center for Biodiversity, Illinois Natural History Survey
Kathleen R. Methven	Center for Biodiversity, Illinois Natural History Survey
Lawrence M. Page	Center for Biodiversity, Illinois Natural History Survey
Christopher A. Phillips	Center for Biodiversity, Illinois Natural History Survey
John Taft	Center for Biodiversity, Illinois Natural History Survey
Douglas A. Yanega	Center for Biodiversity, Illinois Natural History Survey

Developed through:

Center for Biodiversity
Illinois Natural History Survey
607 E. Peabody Drive
Champaign, IL 61820

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Research and Planning
Illinois Department of Natural Resources
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CHAPTER 1
GENERAL OVERVIEW

1.1 Introduction

The Critical Trends Assessment Program has identified, as its primary goals, the dual purpose of creating a habitat monitoring program that will allow an assessment of trends in the quality of Illinois' natural habitats and increasing environmental awareness among the people of Illinois. Toward this end the EcoWatch programs seek to employ citizen volunteers to collect the baseline data that will provide the basic trend analysis for habitat quality. This approach to environmental monitoring creates a number of very difficult problems at the outset. Volunteer data collectors will typically carry relatively little expertise to identify organisms. Second, instrumentation must be simple and cheap as many groups may simultaneously implement to sampling protocols. Third, data collectors are likely to change through time such that the EcoWatch programs must remain vigilant in maintaining data quality standards. It should be noted that this description of EcoWatch includes the ForestWatch, RiparianWatch, PrairieWatch and WetlandWatch modules, but does not include RiverWatch. RiverWatch was developed prior to, and independent of, the remaining EcoWatch modules.

The particular goal of the EcoWatch programs described herein is to implement sampling primarily in conjunction with high school environmental science curricula. Thus, high school students are targeted as the primary data collectors for EcoWatch. High school students, however, are not the only target group for which these monitoring protocols are appropriate. Owing to the stated goal of linking EcoWatch monitoring protocols with Illinois high school science curriculum, however, the text often refers to teachers, students, and classes. These terms are interchangeable with coordinator, volunteer and strategy planning meetings, respectively. The strategy of targeting high school classes allows for increased consistency through the constancy of the facilitator (biology teacher) through time. Consistency in participants may be even better among other types of volunteer groups. While consistency is advantageous, it is not necessary.

The primary challenge in designing the EcoWatch protocols is to select a suite of measurement variables that are both environmentally meaningful with respect to assessing trends in habitat quality and also simple enough to be conducted by untrained volunteers with relatively little experience in identifying biota and using scientific instruments. Recent scientific literature has focused on the efficacy of using simple measures to reflect the complex array of variables that constitute what we consider to be ecological health (Costanza et al. 1992), habitat quality or environmental condition (Goldsmith 1991, Spellerberg 1991, 1992, McKenzie et al. 1992a,b).

We adopt a view that there is not likely to be any single measure that will portray what we want to know about habitat quality within natural systems. What we need in order to monitor general environmental quality is a suite of variables that each tell us a little bit about the broader condition of the environment. This is sensible in that there are numerous ways in which habitats may degrade (i.e., species invasion, reduced nutrient flows and biomass production, an imbalance in species abundances through a loss of predators, loss of biodiversity within specific taxonomic groups). Each type of environmental change in habitat quality might be expected to affect different groups of organisms differently. As a result we view the suite of data collected under EcoWatch as a suite of ecological indicators in the same manner that we use a suite of economic indicators as a bellwether of economic condition.

Despite several claims of certain taxa acting as appropriate indicators of diversity (e.g., Pearson and Cassola 1992), finding simple ecological indicator species that can be used to distinguish between the overall diversity of sites is not likely (Lawton et al. 1994, Pendergast 1997). The process of indicator selection is fraught with biological prejudices regarding important phenomena, and taxonomic parochialism. EcoWatch sampling side-steps this problematic issue. EcoWatch indicators are not meant as a tool to compare the habitat quality between sites. Instead, EcoWatch measures are used to assess changes of the habitat quality within sites across time. Thus, several constraints of site comparison are avoided. For example, sites that vary in species diversity may actually vary in the potential diversity of that group of species. The result is that the same measure of an indicator value may mean different things in different sites. A site containing a relatively small number of species in a group may, in one case signal degradation, while in another indicate nothing. These measures, however, should retain their ecological information through time within individual sites. A response variable that is not be a particularly effective indicator of habitat quality when comparing between sites ought still to be a good indicator of changes in site quality within a single location when followed through time. Inter-site comparisons will be restricted to lumping several sites by common characteristics (e.g., ownership, natural division, overstory dominant species) and comparing groups of sites using standardized response variables to indicate the relative magnitude and direction of general region-wide ecological changes.

Nonetheless, we would like a generalized picture of changes in habitat quality. Thus, with each EcoWatch module we specify monitoring modules that track a similar basic set of 5 ecological measures. First, we are interested in structural complexity and diversity of the vegetation. These measures address whether the habitat is maintaining vascular plant diversity. Second, we monitor the effect of exotic plant species. Exotic plants are widely recognized as one of the leading causes of environmental degradation within habitats. Third, we identify plant species that are considered sensitive to environmental degradation (e.g., grazing, browsing, trampling) and monitor populations of these plant species that we use as an indicator of the quality of the vegetation. Fourth, despite problems with counting animals when using a large number of volunteers, we collect information on how good the habitat may be for hard to observe vertebrates, and use some measure to gauge diversity or density of the more easily observed

faunal groups. Fifth, we attempt to quantify the effects of human impact through both pollution, as manifested in plant growth, and human use (e.g., trails, trash, pets, etc). We feel that these general groups of measures covers the basic issues of interest with respect to monitoring changes in habitat quality. Naturally, we are also interested in monitoring changes in the abundance of natural habitats. This, however, is beyond the scope of this project and encompassed in other on-going CTAP monitoring projects.

1.2 The Structure of Sampling Protocols

As a result of this monitoring program being targeted to high school students, each protocol is designed to use a team approach to goal accomplishment. Protocol descriptions contain: 1) clear and concise statements regarding the specific question and goal of each protocol, 2) a longer statement of the broader purpose of the data, 3) a list of materials required, 4) a detailed procedural description, 5) a task checklist, and 6) data sheets. The procedures are generously illustrated for ready assimilation of the data collection procedures. The protocols are designed to occupy a class of approximately 25 students 2 half days in the field and ½ day in class time. This time schedule will probably be difficult to accomplish if students are not prepared to visit the field site having already been assigned to groups and having prepared by reading through the materials for their protocols. It is not intended that all students accomplish all tasks. Thus, we also recommend a ½ day reporting seminar where students can inform one another of the results of their sampling.

While the high school class model was used to design the protocols, other groups may use these methods as well. We include an additional section (Part 3) for groups that may be able to dedicate more time to the collection of data such that they may move beyond the measures in the primary units (Parts 1 and 2). In addition, this manual suggests other protocols that may be used for advanced groups, or be used to replace primary protocols if they prove to be either untenable or uninformative. Part 3 protocols generally require additional expertise and time.

1.3 Conforming to the EcoWatch Protocols

In order for the data collected under the auspices of EcoWatch to be analyzed the methodologies must be strictly followed. When problems arise such that a particular unit seems unworkable, these units may be changed through the central administration. Individual groups, however, cannot selectively choose protocols and still have their data used for the statewide analyses. We understand that participation by some schools will be primarily for educational purposes. While this is acceptable, the data can not be incorporated into the database unless the methodologies have been followed. Thus, we expect complete compliance to methods, but also accept constructive criticism on our methods.

This rule is required for data standardization and consistency. We do not require it because we feel that these are the best measures available. While we have tried to provide the best measures available, we recognize that refinement of these methods is expected. Appendix 1 contains a draft of a suggested letter to volunteer coordinators to explain the EcoWatch position on this issue.

Several groups may have the capacity, and desire, to collect data that exceeds the expectations of EcoWatch. For example, they may identify all trees to species, rather than genus. This additional data is welcome within EcoWatch, but the database development must be careful to allow a condensation of these more precise measures into their appropriate categories.

1.4 General Methods for Characterizing Habitats

There is an on-going debate regarding the best way to collect data for the classification of vegetation. This debate is important in that we must be able to objectively defend any vegetation classification system such that sites may be reliably classified. The standard methodology for classification world-wide has been through the use of releve's and standard phytosociological methods (e.g., Braun-Blanquet). We opted not to follow this standard for several specific reasons. First and foremost, North American vegetation classification has generally adopted a classification system based on canopy dominant species. We feel that the growing support to adopt some standard methodology and classify vegetation in North America requires of us to justify our methodology.

Our rationale is as follows. First, site classification is not the primary goal of the study. Thus, we feel less compelled to fit the sampling to the mold used primarily for site classification. It would, however, be useful to classify sites by vegetation type using a standard format so that these monitoring results may be compared to such a vegetation classification scheme. At present, classification by stand dominants is the more frequently used methodology. Our stand sampling of dominant species to genus facilitates this type of classification. Second, collecting data based on releve's requires expert knowledge. Data collectors must be able to identify all vascular plants to species. We simply cannot expect this level of expertise from volunteers. Our level of identification expectation precludes the use of releve's. Third, releve's require extensive natural history knowledge and prior experience in the selection of plot size and the placement of those plots. We do not feel the need to burden volunteers with these difficult decisions.

The aforementioned arguments pertain most closely to ForestWatch and RiparianWatch. PrairieWatch will begin with a site classification based on the Illinois Natural Areas Inventory (INAI) classification since all sites used for PrairieWatch are chosen from the INAI site database. As a result, characterization of the site involves primarily measures of biotic diversity and characterization (species-area curve, and grass to forb ratio). WetlandWatch sites, similarly, are chosen from a pre-existing National Wetlands Inventory (NWI) database. These sites are already

classified by wetland type. Sampling will be restricted to information verifying the site type and measures of diversity (species-area, species composition)

1.5 Monitoring Versus Surveillance

Spellerberg (1991) defines monitoring as the science of measuring changes in some parameter through time under the constraint that a response level is identified that would trigger a management response. Tracking environmental measures through time without a specific target level that would require a response is termed surveillance. Under these definitions, surveillance is generally a pre-requisite for monitoring as it is used to establish expected levels of variation such that extremes for action responses may be targeted. The EcoWatch modules, at this point, are technically surveillance programs. After several years of monitoring fluctuations in environmental measures it may be easier to identify response values that would elicit management concern. It should be noted, however, that EcoWatch may be best utilized as a means to identify critical changes in habitat conditions that would merit further, and more sophisticated, examination by scientific experts. In this regard, EcoWatch serves as a general monitoring device and a means to target potential problems that would elicit further targeted research before management actions are deemed necessary.

1.6 Season of Sampling.

ForestWatch is designed for sampling in the spring immediately following full leaf-out. Several of the disturbance-sensitive plants are spring ephemeral plants that will disappear from the forest floor by mid-summer. The tree health measures, however require foliage. ForestWatch protocols may also be sampled once in the fall (for tree health) and once in the spring (for disturbance-sensitive species). RiparianWatch will require a fall sampling schedule, as riparian zones are often too wet for spring sampling. We are currently re-evaluating whether it will remain feasible to have a relatively narrow spring sampling window for ForestWatch, and may consider shifting a portion of these sampling protocols to autumn. PrairieWatch is designed to be sampled in the autumn, but could also be effectively implemented in the late summer prior to the start of school. WetlandWatch, likewise, is designed as a late summer or autumn sampling program.

CHAPTER 2
SITE SELECTION

2.1 ForestWatch and RiparianWatch

Forest site selection (ForestWatch, RiparianWatch) will be done using the Land Cover map generated by the 1990's satellite images and now digitally classified (INHS- Don Lumen et al.). We initially select this database to exclude all non-forest habitat. Among forested sites, we exclude open canopy forests as these are primarily partially urbanized habitats (e.g., large yards, golf courses, picnic areas within parks) or natural savanna habitats. This site selection excludes savannas. We feel that savannas are better sampled within the context of PrairieWatch and will be selected through methodologies in that unit. Selection of sites using this database, however, will occasionally result in inappropriate sites (e.g., wooded parks) being listed as potential sampling sites. Coordinators will be given a list of potential sites and be allowed to exclude sites that are inaccessible or otherwise unusable.

For all ForestWatch sites we further exclude all forests that are less than 6 ha in size (the minimum required to establish the monitoring transects). We further exclude patches that are less than 200 m along one dimension (i.e., long thin riparian strips). Among the remaining sites we will retain all potential forest patches as possible sampling sites. Several decision remain in order to make this data selection. We separately calculate area for patches that are divided by a road right of way wide enough to be a paved highway (e.g., 15 m). Smaller road breaks, such as trails, old logging roads and through a patch are acceptable within the context of a single forest site. Second, any narrowing of a site to less than 100 m for a distance of more that 100 m is sufficient to truncate the forest polygon. Thus, forest patches that are connected by a narrow riparian strip may be segregated into two separate patches. Finally, sites included within ForestWatch may belong to the same large forest patch but must be separated by a minimum distance of 2 km so that their surrounding land use measures are not overlapping. We recommend separation of at least 5 km if possible.

RiparianWatch sites are also selected using the Illinois land cover classification. In this case, any site that is: a) at least 300 m long; b) 30 m (1 pixel) wide; and c) along a stream may be used.

2.2 PrairieWatch and WetlandWatch

Prairies are not well distinguished from pasture and degraded grasslands by the satellite image derived Illinois land cover database. We use the Illinois Natural Areas Inventory to identify grade A, B, and C prairies that are in excess of 5 acres in size. All sites are available for use. Dedicated natural areas sites are excluded from use by high school classes. It is our hope that volunteer stewards and natural heritage biologists can sample a subset of these sites to enhance

the sample size. Because of the rarity of appropriate prairie sites it may be necessary to solicit participation of schools located near target prairie sites. Many schools will not have appropriate sites within a reasonable driving distance.

WetlandWatch uses the National Wetlands Inventory (NWI) for sites selection (Cowardin et al. 1979). In this case, we eliminate forested wetlands (bottomland forests) and riparian scrub-shrub wetlands in order to restrict our attention emergent herbaceous-dominated wetlands. Thus, any emergent wetland, or a scrub-shrub wetland not associated with a river are within the sampling regime.

CHAPTER 3
FORESTWATCH

3.1. Protocol 1.1 Characterizing the Site

Objective. This protocol uses topographic maps, aerial photos, and land-ownership maps to characterize the physical and political characteristics of the study site. The purpose of gathering this information is to allow classification of sites into groups for analysis.

Rationale. At present we envision a classification of sites as outlined in Table 1. Classification measures may be analyzed singly or, if sample sizes allow, in conjunction with other classification measures (e.g., small publicly owned sites vs. small privately owned sites). The purpose of this categorization is to allow CTAP to distinguish whether trends in any particular response variable(s) differ in sites with differing characteristics. It is possible to underestimate, or miss altogether, important trends in habitat quality as a result of trends moving in opposite directions in sites that vary in some key characteristic (e.g., a rare plant species declining in southern Illinois while increasing in northern Illinois). As with the majority of protocols there are an abundance of ways in which these data may be analyzed. We designed the data collection so as to be as flexible as possible. We envision a reduction of analysis measures such that not all variables are analyzed in all possible combinations contrasted among all possible site classification schemes. This would be laborious and something of a statistical fishing expedition. Instead we envision an analytical approach of analyzing a summary response variable from each protocol by each of the classification measures (individually). More detailed analysis of specific response measures or combinations of classification variables would be done as specific hypotheses suggest them (i.e., if habitat degradation through high deer browse is thought to be more pronounced in one natural division than another or more on lands under public than privately ownership).

It can be argued that site characterization, and surrounding land use may be better done using the GIS coverage of sites. This is not entirely true because the GIS coverage has difficulty separating pastures from crops and prairies. Similarly, the GIS coverage does not distinguish among farm buildings, suburban houses or industrial centers. Thus, a filed check or aerial photo interpretation may provide an additional way to classify surrounding land use of sites. This could, however, be coupled with an additional data field that summarizes a GIS assessment of surrounding land use. This latter tool has not yet been developed.

Data Analysis. As a specific example, we recommend using the surrounding land use score as a measure of the nature of the forest edge. Those forests surrounded by larger amounts of forest may be more likely to retain biodiversity, those sites surrounded by industrial development may

be more threatened by pollutants, and those sites surrounded by row crops and pasture may be more prone to plant invasion. Thus, we score forest=1; pasture=2, cropland =3, residential=4, commercial =5 and weight surrounding land use by distance. For this measure we use a value of 2 times the score for points 0.5 km distant and 1 times the score for points 1 km distant. These scores are summed for points at 0.5 and 1 km distant from the measured site in each of the four cardinal directions. This raw index will vary from 12 to 60. Dividing the raw value by 12 will result in a relative value ranging from 1 to 5. By rounding to the nearest integer, sites may be grouped for analysis by level of surrounding land use impact bearing in mind that this score is merely a rough measure of the potential impact of surrounding land use on forest health.

Table 3.1. ForestWatch site classification variables

Categorization	**Divisions used for contrasting forest response (number of units)**	
1. Region	Northern, southern, and western edges, central Illinois	4
2. Natural Division	the natural divisions of Illinois (Schwegman et al 1973).	14
3. Land Ownership	private, public, dedicated nature reserve	3
4. Tract size	acreage	C
5. Surrounding land use	Forest, pasture, cropland, residential, commercial	C
6. Topographic position	upland, bottomland	2
7. Topography	flat, rolling, even slope	3
8. Dominant cover type	e.g., oak-hickory, maple, ash-elm-red maple	6
9. Stand maturity	density of trees >50 cm dbh	C
10. Land use	e.g., grazed, managed for timber production	6

C = continuous variable for which classes may be divided based on the distribution of sites.

3.2. Protocol 1.2 Monitoring Transects

Objective. Establish six permanent transects and characterize the soil at three points along the transect. These transects will be visited annually by different students making the same measurements each year.

Rationale. The primary goal of ForestWatch is to characterize changes in habitat quality through

time in a large number of sites. The most obvious and easily assessed manifestation of forest habitat quality is through major structural characteristics of forests. To this end we decided to dedicate a substantial component of the student habitat sampling to describing the size structure and species composition of the dominant trees (2.1), density of exotic species (2.2a), habitat complexity (2.2b), and other measures. In choosing a specific methodology for these protocols we were faced with the potential trade-off between increasing the repeatability of samples (permanently marked and re-sampled plots) and accurate characterization of the individual site (using random sampling within sites).

Random sampling provides a more accurate characterization of the site as a whole, but reduced precision as the variability within sites may be expressed differently among years by chance alone. If samples are sufficiently extensive such that we could assume that inter-year differences in response variables were due to temporal changes and not random sampling effects. Since the visit of each group to each site is relatively brief we could make no such assurance. We concluded that random samples within sites would not be appropriate owing to the potentially large noise to signal ratios as a result of the small total portion of each site that could be sampled in any one year.

Since the goal of characterizing site quality is to develop a state-wide habitat quality assessment the specific conditions of any one site are less important than getting trends through time. Thus, we decided to focus on increasing precision within sites at the risk of decreasing the accuracy with which any one site that is assessed. To do this we have students establish permanent sampling transects that will allow resampling of specific locations within sites. This serves as a random sample among sites that, when done in large quantity will result in an accurate conglomerate picture of habitat quality. Further, since sites are resampled in the same location each year, trends over the short term, within sites, can be considered real trends. The re-sampling of a permanent quadrat is also viewed as beneficial because it focuses the potential impacts of site visits to just one location within sites.

It should be noted that the rationale for establishing six parallel transects was to keep groups separated but within close proximity for coordinator supervision. These transects are not meant as replicate samples within a site from which to calculate a mean and variance for any response variable. The transects are just 15 m from one another, and are not likely to be independent samples of the forest. Thus using them as samples from which to calculate a mean and variance would be statistically inappropriate. We have designed the study to use the aggregate of the sample from each transect as a single response measure.

Data Analysis. None.

3.3. Protocol 2.1 Measuring Forest Structure

Objective. Record the location, genus, and size of all trees larger than 15 cm in circumference

and within 3 m of the transects. This information on the distribution, abundance, and sizes of trees is restricted to generic identification for the most common trees in Illinois. These data will be used to assess size structure of the forest, examine for edge effects within the forest, examine recruitment of trees into the forest, and over time, examine canopy mortality rates of trees.

Rationale. Forest structure, as measured by the dominant canopy trees and their recruits, is perhaps the single most useful descriptor of forest quality that can be measured. Thus, all students devote the first portion of their effort toward collecting baseline data on the size distribution and abundance of trees within each forest. The greatest challenge this provides students is in tree identification. The CTAP team agreed that tree identification to genus for eight common genera (maple, oak, elm, ash, walnut, hickory, beech, and pine) could be accomplished by a simple key, a pictorial display of key characters and a small time investment by the student. While there are numerous oaks and hickories and many play different ecological roles in differing forest habitats, there are few instances when the combination of these genera would allow for a misclassification of forest habitat or a misinterpretation of forest dynamics.

A generic level of taxonomic identification is sufficient to learn several key points about each forest. First, we want to know something about the type of forest habitat the students are sampling. For example, ash, elm and red maple are characteristic of bottomland forests. A site description and the presence of these trees would suffice to characterize a site as a bottomland site. Similarly, beech, walnut and maple are characteristic of rich, mesic sites, while oaks and hickories more frequently typify drier and more xeric forest sites. Pine as the dominant tree species, outside of the very few natural pine stands within Illinois, is characteristic of sites managed for timber production. Finally, one of the great changes in Illinois forests during the 20th century has been a shift from oak-hickory to maple-beech dominance in many forests. This is largely the result of fire suppression. Estimating the abundance of these genera in the various size classes will provide information on the continuation of this effect, or its reversal in sites with active fire management.

We have students identify trees in transect intervals for two reasons. First, this will help students, when revisiting sites, to relocate specific individuals when questions arise whether a particular tree was considered in or out of the transect in a previous census. Second, this identification would allow the analysis of forest structure to include a measure of edge effect. Do certain forest types show stronger edge effects than others? Does forest succession happen more rapidly, or more slowly along the forest edge? How wide is a forest edge with respect to trees? Does the width of a forest edge vary with aspect?

Finally, students record trees in size classes. Size classes were used because we are not measuring growth rates of individual trees. We simply want to classify the forest into: 1) old-mature; young mature; maturing; and young based on the abundance of trees of differing sizes; 2) stable or transitional based on the relative abundances of trees in smaller and larger size classes; and 3) into forest type. We do not require specific sizes for any of these assessments. Simple size

classes will do. We decided to limit the study to five size classes that could be readily distinguished with a few simple field tools.

Data Analysis. To accomplish the three aforementioned goals, site data analysis will construct the following three variables to be used for a temporal analysis. First, we anticipate density of larger trees (>50 cm dbh) to range between 0, in immature stands, to about 25 trees in mature stands based on the 3600 m^2 sampling area (6 transects of 600 m^2 each). For each forest the midpoint of size categories will be used to calculate a basal area. The size class with the dominant basal area will be used to assign a forest into a maturity category. For this analysis, trees in the 50-75 cm dbh and >75 cm dbh categories are summed. Forests dominated by this largest category are defined as mature (1) stands. Basal area dominance by 25-50 cm dbh trees is classified as nearly mature (2). Dominance by 12.5-25 cm dbh trees is maturing (3), while basal area dominance (not density dominance) by the smallest size class is a young (4) stand. These categories are split into numeric categories as shown parenthetically above.

The second goal is to assess stability. Three computational steps are required. First, calculate the density (stems per ha) of each taxa within each size category. Second, relativize each density measure by dividing the density for each taxa in each size class by the summed total density for that size class. Third calculate the mean relative density for each taxa across size classes. Fourth, sum the squared difference between the mean and each observation for each taxa in each size class. Missing taxa will contribute zero to this score. Those taxa that are equally represented in each size class will contribute zero to this score. Increasing variation among size classes for a taxa will increase this score. Thus, high scores represent potentially unstable forest composition (i.e., forests where representation in one size class differs from that in other size classes suggesting a potential for compositional change over the ensuing decades). Unequal mortality rates among species may cause apparently stable forests to become transitional and visa versa, but at a glance this is our best estimator of forest compositional stability. Tracking this measure through time will allow continual assessment of the apparent rates of change in various forest types in Illinois.

The third goal is to classify forests into types. To accomplish this task importance values will be calculated for each taxa. The taxa combination (e.g., oak-hickory; maple-beech, elm-ash) will be used to set a classification. Importance values are calculated as the sum of relative density and relative basal area. To calculate relative basal area you add the total basal area of each taxa using the midpoint of size classes then divide the basal area of each taxa by the total and multiply by 100. Next calculate relative density in the same manner. Sum the total number of stems sampled and divide the number for each taxa by the total and multiply by 100. Summing relative basal area and relative density is the importance value. Importance values range from 0 to 200. The final step is to rank the taxa by importance value and categorize the site by dominance of oak and hickory, beech and maple, elm and ash, pine, or other. Fitting in a category does not require the presence, or dominance of both species in a grouping, just the net dominance by one group or another.

3.4. Protocol 2.2a Non-Native Species Survey

Objective. Record the presence (and density) or absence of four species and two genera of invasive non-native plants (garlic mustard, rocket, European high-bush cranberry, multiflora rose, honeysuckle, and buckthorn). Annually recording this information on the distribution and abundance of these plants will help biologists detect changes and assess whether they are crowding out native Illinois plants.

Rationale. One of the key threats to forest health that is not monitored well anywhere is the threat of biological pollution. We have numerous lists of species that are non-native, a limited ability to retrace their movement into a region, and no formal way of assessing changes in abundance once species have arrived. The historical records from which we may glean a past expansion are typically limited to collection dates and locations of herbarium and museum collections. These data are not sufficient to estimate the magnitude of the impact of non-native species, nor their dynamics. In this protocol we have chosen several exotic species based on: 1) their ability to invade forests beyond the forest boundary; 2) a large purported impact on native forest biota; and 3) because they are readily identifiable and not easily confused with similar taxa. We focus on plants because they are much easier to monitor from year to year. In this case, identification does not rely on a taxonomic key because the numeric majority of species would be classified as "other". Instead we rely on pictorial examples with key characteristics highlighted. One major question for initial implementation is whether this is sufficient for accurate identification. We may need to require submission of a voucher specimen from groups when they encounter a target species.

For each of the six target species we strive for three pieces of information from the data collected by the volunteers. First, by surveying the forest in general we attempt to identify presence or absence of a taxa within a site. Second, by identifying presence/absence within each 10 m section of transects we can estimate a spatial extent of populations in order to assess whether the population is expanding within a particular site. Third, by recording a measure of density within each 10 m section we assess whether population density is expanding within infected portions of the forest. To measure density we have devised a method that is as economical as possible. Within each 10 m interval volunteers will count all individuals when a population is in low density. If a particular species is very dense, this could take an undue amount of time for little additional information. Instead the volunteers switch to measuring the area occupied by 100 individuals. This measure is then converted to an estimated density over the 10 m transect segment. For this switch to remain valid volunteers must not choose the densest, or most convenient, patch in which to measure area, but begin at a set point (i.e., the beginning end of the 10 m transect segment) such that we can treat the sample as an unbiased, even if occasionally unrepresentative, sample.

Data Analysis. These data may be analyzed in two ways. First, and most importantly, changes in regional extent, extent within forests and density within forests may be analyzed species by

species. These analyses may be lumped for the whole state or considered by any site classification combination. Secondly, an overall impact variable may be constructed by summing an importance value type of measure for each non-native species within a site. Importance values are constructed by averaging frequency, density and basal area measures for trees. In this case, occurrences may be weighted by the frequency of transect segments occupied and the density within each segment to obtain a score for each species. We suggest following the logic of Daubenmire's modification of the Braun-Blanquet cover class system by scoring a 1 for site presence outside of the transect, and a score of 2-6 within each occupied segment based on the density within occupied segments as follows: 2 = 1-5 plants within the segment, 3 = 5-25 plants within the segment, 4 = 25-100 plants within the segment, 5 = 5-25 plants/m^2, 6 = >25 plants/m^2. Five plants per square meter equals 100 plants segment. Site scores equal 1 (the minimum value to indicate presence) plus the mean segment score. All species scores can be summed to gain an overall measure of non-native species impact within a site. Values for each species, as well as an aggregate score are recorded through time within sites.

3.5. Protocol 2.2b Habitat Complexity

Objective. To classify the habitat by its complexity as a surrogate of how suitable the site is for a wide variety of taxa. These measures include both nonliving habitat resources (e.g., dead and downed wood, depth of the duff layer) and living habitat resources (e.g., shrub and below-canopy foliage density). Regularly collecting this information on the distribution and abundance of dead and decaying vegetation and on living vegetation allows biologists to assess habitat availability in the understory of the forest.

Rationale. Animal density is typically hard to assess. The presence of large volunteer groups causes problems in assessing the abundance of larger vertebrates such as deer, birds or squirrels. Taxonomic difficulties make it hard to expect volunteers to assess the density and diversity of decaying organisms (e.g., fungi) or invertebrates. Yet these difficult to census plants and animals represent the vast majority of species diversity within forests and are important to assess in some manner. Habitat complexity provides a surrogate for this diversity by suggesting the diversity of organisms that may be supported by the Illinois forests (although this measure is no guarantee that these organisms actually are within any one forest).

To describe habitat complexity volunteers will be asked to assess three specific measures: litter (duff) depth, the abundance of woody debris, and the complexity of sub-canopy vegetation. Litter depth and woody debris measures are borrowed from the U.S. Forest Service's guide to measuring fuel loads for assessing fire capacity of forests (Brown 1974). The vegetative complexity measure is adapted from methods used to estimate understory bird habitat. The philosophy is simple. We understand, through a vast wealth of observational studies, that bird usage of habitats increases with increasing structural complexity of forest understories. Thus we measure this without regard to specific composition. These measures are quick and require no

specific identifications. Thus, these measures are readily accomplished by untrained volunteers.

Litter/Duff depth is described by the mean depth from the surface of the litter to mineral soil as sampled in numerous places. Woody debris is characterized by size of fallen branches and trees that intersect the 100 x 6 m transects. All pieces of dead wood are tallied and summed as a basal area of dead wood per hectare in the same manner as basal area is calculated for living trees. In this case, however, dead stems may have differing lengths, so this measure becomes an estimate of total wood volume. Wood is categorized into solid and rotten. Vegetation complexity is measured by estimating the percentage of a standardized board may be clearly viewed at a distance of 10m in much the way a secchi disk is used to measure water clarity.

Salvage of dead and downed timber is a frequent management practice that diminishes habitat quality. Removing dead timber decreases potential habitat for organisms that structural complexity such as standing dead trees for protection. For example, populations of cavity nesting birds are often threatened by a lack of nesting site availability. Dead wood on the forest floor also provides habitat and protection for salamanders, snakes, frogs, toads and many insects. Removing dead wood also removes food resources for organisms that use dead wood as a food resource and decay these materials. These organisms require the dead wood as a food resource and, in return, recycle valuable nutrients back to the forest soil and enhance plant growth. Thus, habitat complexity, while not a specific measure of any single species, is probably a good surrogate for the measuring the ability of a forest to support a diverse array of native species.

Data gathered in this protocol will assess how common timber salvage is in Illinois at present and track changes in salvage through time. Salvaged sites carry very low levels of woody debris. Mature forests typically carry more debris than young and maturing sites. Thus, it is important to analyze woody debris within forest maturity classes such that one can distinguish between trends in habitat complexity as a result of changes in forest maturity or as a result changing management practices.

Similarly, understory vegetation provides feeding, roosting and nesting opportunities for forest birds as well as many native forest insects. Browsing by deer, grazing by cattle and dense overstory canopies all reduce understory shrub density. Similar to the woody debris measure, understory vegetation must be analyzed within forest maturity classes to distinguish trends in forest structure from trends in forest maturity.

Data Analysis. Response variables in each case will be a single number for litter depth, woody debris and vegetative complexity for each forest. Litter/duff depth will be summarized by the mean of 10 observations along a sample transect. More data may be collected if time permits. Additional samples will improve the estimate of litter/duff depth. The primary woody debris value is summarized by summing the number of observed stems in each diameter class. The midpoint of each range is used to estimate an area for each size class, multiplied by the total number of stems (rotten and sound) for each size class and summed to give a total area of dead

unit per unit area sampled. Secondary woody debris values may be calculated using sound and rotten wood as separate measures. These measures may be more sensitive to short-term changes as rotten wood is never salvaged and thus represents a long-term signal for a measure that may change over shorter time periods. Limiting the analysis to sound wood may be a more sensitive bellwether of habitat management practices.

Understory vegetation is summarized as the mean number of visible squares for each direction (4) and at each distance (5) within each height class (3). This results in three summary values (0, 1, 2 m high) with 20 observations for each. A single primary response variable is calculated from the mean of the density at the three different heights. Individual heights (0,1,2 m) are used as secondary response measures.

3.6. Protocol 2.2c Animal Life

Objective. Census the species of snakes and salamanders found underneath boards and count spiders and spider webs in order to make an estimate of habitat usage by readily observable faunal groups.

Rationale. Few animals provide good targets of monitoring under the constraints of ForestWatch. Namely, that target individuals are not disturbed by a relatively large group of people moving through the forest, and that they are readily identifiable by untrained volunteers. Monitoring the abundance of animals, however, can detect specific changes in forest quality over time. Amphibians, for example, are thought to be very sensitive to disturbance or pollution. Trends in amphibian populations are currently being tracked all over the world in an effort to determine if there is a world-wide amphibian decline and whether this represents a biodiversity crisis. By censusing amphibians in Illinois forests, we can participate in this global effort.

Further, the presence of a diversity of predators often suggests a diversity of prey. By censusing for snakes and spiders we target small predators that may represent important trophic links in Midwestern forests. Snakes and salamanders represent good monitoring targets because there are few species and these can generally be distinguished to species with the simple pictorial guide presented in the manual. Further, these organisms tend to hide under debris on the forest floor. Thus, placing standardized sample boards for set periods of time allow for unbiased sampling of different forest types.

Spiders are not easily identified by the untrained volunteer, but many leave visible sign of their presence through their webs. Spiders vary in their natural histories with respect to webs. Some do not spin webs, others spin a variety of types of webs (e.g., orb, funnel). ForestWatch will collect data only on that subset of spiders that spin orb webs. Orb webs are the typical type of web that people envision when thinking of a spider web. As they are placed in vegetation above the ground, orb webs are the most recognizable and easiest to locate in the forest. Finally,

relative spider density may be estimated by simply shaking them out of a tree into some sort of simple bin in which they are temporarily trapped (in this case, an umbrella).

Data Analysis. The ForestWatch database contains a field for the number of snakes and amphibians of each type observed within each site. For most sites these observations will be rare. Thus, interannual variability in sampling is likely to swamp the trends in any individual site for any species. Thus, summing all observations within a site may allow a trend analysis. Otherwise, observations will need to be summed, and then divided by the number of sites sampled, for sites that share a characteristic over which the response will be evaluated (e.g., upland versus bottomland sites). Further, the behavior of these organisms varies with weather (i.e., snakes are more likely to be out sunning in warm sunny weather and under boards in cool rainy weather. Thus, we record weather information and should use this as a co-variate for analysis since most volunteers will not be able to choose to sample under a standard set of weather conditions. An analysis of observations by weather conditions after sufficient data has been gathered will allow an assessment of the strength of this effect. Data analysts may then choose to either give observations under poor weather conditions a lesser weight in predicting density, or discard these data altogether.

For spiders the data will be summarized as the total number of: 1) webs; 2) spiders; and 3) types of spiders observed. Since these are not likely to be on similar scales (i.e., volunteers will count many more webs than spiders and many more spiders than types of spiders), these measures should remain separate for analysis. In an effort to minimize the number of response variables to be analyzed for output, an attempt at scaling these values to create a single response variable that captures all of these data is encouraged. To do accomplish this, see the section on general data analytical techniques.

3.7. Protocol 2.2d Tree Health

Objective. Record genus, height, crown density, foliage transparency, crown ratio, and trunk condition of five canopy trees selected along the transect. For 15 selected saplings, record genus, vigor, and crown ratio. Changes in the health of individual trees in the forest can identify problems.

Rationale. The U.S. Environmental Protection Agency and the U.S. Forest Service have cooperatively developed a forest health monitoring program that focuses on early detection of the signs of acid rain and pollution damage in U.S. forests (Conkling and Byers 1992). This program, while primarily designed for detection of pollution damage, will indiscriminately assess damage to trees that may be a result of defoliating insects, pathogens or storm damage. This is an important measure as the declining condition of the foliage of canopy trees can result, ultimately in undesirable forest loss and high tree mortalities. ForestWatch has adopted this methodology with the aim of presenting early detection of forest damage. Thus, this may be the most

important measure collected in the ForestWatch program, but also the most vague. This measure can not assign a cause for the patterns observed. A signal of declining of crown density, or increasing foliar transparency would suggest alerting scientists to the problem such that they may focus a specific study to determine the mechanism of the degradation. For example, foliar loss may result from wind damage, insect outbreaks, disease agents, or pollutants. We would predict a more localized spatial extent of wind disturbance, and expanding centers of damage from other mechanisms. The specific justifications for each measure are laid out in the Forest Services' Forest Health Monitoring Field Methods Guide (Conkling and Byers 1992) and will not be elaborated upon here.

Data Analysis. Each site will contain a minimum of 5 trees of each taxa for which crown density, foliar transparency, crown ratio and stem condition data are collected. Thus, sites can not be analyzed individually. Instead, the ForestWatch database will contain fields to track the mean values for taxa summarized by region of the state and for the state as a whole. Similarly, crown ratio and vigor class for saplings will be summarized by type of site or at a regional scale (i.e., summarizing by the 14 natural divisions within Illinois is likely to result in too small of sample sizes). Data are to be reported as a simple mean of the observation values for each taxa. An example of summarized data of this sort is found in a recent USDA report (USDA 1993).

3.8. Protocol 2.2e Disturbance-Sensitive Species

Objective. Record the presence (and density) or absence of six species of plants sensitive to human disturbance (blue cohosh, maidenhair fern, small bellwort, doll's eyes, white trillium or yellow trout lily, and bleeding hearts or spiderwort). Annually recording this information will detect changes in the distribution and abundance of these plants and will help biologists assess whether conditions for native plants are improving or deteriorating in Illinois.

Rationale. One of the key indicators of degrading forest health is the loss of disturbance intolerant species. These species may be extirpated from a forest habitat through mechanical disturbances such as grazing or logging; or from changed disturbance regimes such as fire suppression and mesophytic succession. Similar to non-native species, we can track the distribution of these species, but have no formal way of assessing changes in abundance within sites. The historical records from which we may glean a past distribution are typically limited to collection dates and locations of herbarium and museum collections. These data are not sufficient to estimate the magnitude of the impact of habitat loss on the dynamics of disturbance-sensitive species. In this protocol we have chosen several disturbance-sensitive species based on: 1) their presence in high quality forests; 2) an observed propensity for extirpation with disturbance; and 3) because they are readily identifiable and not easily confused with similar taxa. We focus on plants because they are much easier to monitor from year to year. In this case, identification does not rely on a taxonomic key because the numeric majority of species would be classified as "other". Instead we rely on pictorial examples with key characteristics highlighted. One question

for initial implementation is whether this is sufficient for accurate identification.

For each of the six target species we strive for three pieces of information from the data collected by the volunteers. First, by surveying the forest in general we attempt to identify presence or absence of a taxa within a site. Second, by identifying presence/absence within each 10m section of transects we can determine whether the spatial extent of the population is expanding within a particular site. Third, by recording a measure of density within each 10 m section we assess whether population size, or density, is expanding within infected portions of the forest. To measure density we have devised a method that is as economical as possible. Within each 10 m interval volunteers will count all individuals when a population is in low density. If a particular species is very dense, this could take an undue amount of time for little additional information. Instead the volunteers switch to measuring the area occupied by 100 individuals. This measure is then converted to an estimated density over the 10 m transect segment. For this switch to remain valid volunteers must not choose the densest, or most convenient, patch in which to measure area, but begin at a set point (i.e., the beginning end of the 10 m transect segment) such that we can treat the sample as an unbiased, even if occasionally unrepresentative, sample.

Data Analysis. These data may be analyzed in two ways. First, and most importantly, changes in regional extent, extent within forests and density within forests may be analyzed species by species. These analyses may be lumped for the whole state or considered by any site classification combination. Secondly, an overall variable may be constructed by summing an importance value type of measure for each disturbance-sensitive species within a site. Importance values are constructed by averaging frequency, density and basal area measures for trees. In this case, occurrences will be weighted by the frequency of transect segments occupied and the density within each segment to obtain a score for each species. We suggest following the logic of Daubenmire's modification of the Braun-Blanquet cover class system by scoring a 1 for site presence outside of the transect, and a score of 2-6 within each occupied segment based on the density within occupied segments as follows: 2 = 1-5 plants within the segment, 3 = 5-25 plants within the segment, 4 = 25-100 plants within the segment, 5 = 5-25 plants/m^2, 6 = >25 plants/m^2. Five plants per square meter equals 100 plants segment. Site scores equal 1 (the minimum value to indicate presence) plus the mean segment score. All species scores can be summed to gain an overall measure of non-native species impact within a site. Values for each species, as well as an aggregate score are recorded through time within sites.

3.9. Protocol 2.2f Human Use

Objective. Observe both visible and audible signs of forest activity, including past and present human impacts that affect forest quality. Regularly recording this information on the level of human impact and on how well one can perceive animal use of a forested site allows biologists to assess habitat in terms of human and animal use.

Rationale. To be quite honest, we inserted this segment primarily to allow volunteers a unit to enhance their appreciation of how severely our natural habitats are impacted by human development. Nearly everywhere signs of human impact are visible within Illinois' forests. From tree stumps previously cut, cats meandering through a woods, to the noise from automobile traffic, signs of degradation are everywhere. This segment is also designed to enhance the volunteers appreciation of how one might "read" the history of a stand and current impacts by examining the stand for signs of old roads, trails, refuse, pets, trees that matured in openings rather than in closed forest (i.e., trees that carry large lower branches), tree tip-up mounds, etc.

Data Analysis. We designed this unit with no specific data analysis goals. We are not quite sure what kind of data will be submitted from this unit. We suggest creating data fields in the database to track these variables until a large database is available. Once many sites (e.g., >50) have been censused, one could try a variety of methods to analyze these variables. For example, Table 3.2 lists the attributes collected in Part 2.2f. Each measure is given a +, -, or 0 to indicate whether it represents a good, bad, or neutral sign for forest health. These values could either be summed to create a composite score for good and bad signs of forest quality and these sums could be analyzed for trends through time. Alternatively, standardized scores could be created for variables across a large number of sites. These standardized scores create a unitless value that should be equivalent across variables. Positive and negative attributes could then be summed to be analyzed through time as above. This latter method would be favored if there is a great discrepancy in the total quantity of various attributes. For example, if many more dogs are observed wandering through forests than cats, then any observed cat would add a mere blip to a site relative to the dogs. The observation of a single cat, however, may be a very important piece of information relative to observing dogs. Thus, if the total observations of dogs and cats are standardized, then observing a relatively large number of cats (e.g., 2) would count the same as observing lots of dogs (e.g., 5).

Table 3.2. Attributes of forests tabulated in ForestWatch protocol 2.2f and a hypothetical example.

Attribute	+,-,0	Positive	Negative	Neutral
Fresh cut stumps	-		5	
Decayed stumps	0			3
Trees with objects carved into stem	-		2	
Fresh tip-up mounds	0			6
Prairie grove trees	0			6
Streams	+	0		
Small depressions with standing water	+	3		
Large rocks	0			2
Cows	-		0	
Cats	-		1	
Dogs	-		0	
Domestic animal droppings	-		2	
Wild animal droppings	+	3		
People (not from volunteer group)	-		4	
hiking trails	-		1	
Vehicle trails	-		1	
Large piles of garbage	-		0	
scattered trash (cans and bottles)	-		3	
Squirrel calls	+	5		
Squirrel nests	+	1		
Squirrels (observed)	+	0		
Bird song (by type heard)	+	3		
Birds (observed)	+	2		
Insect sound (by type heard)	+	6		
Automotive traffic	-		2	
AGGREGATE POSITIVE SCORE	23			
AGGREGATE NEGATIVE SCORE	21			

3.10 Protocol 3.1 Insect Census

Objective: To estimate diversity of forest dwelling insect groups through the use of standardized survey methods such as sweep nets, visual surveys, and pitfall traps.

Rationale: Invertebrates represent the largest proportion of above-ground diversity in terrestrial ecosystems. As such it is important to gauge the diversity of critical invertebrate groups. Assessing diversity, however, requires expertise that is probably above the level of the majority of the volunteers in this program. As a result, we have provided a skeleton outline of the preferred procedures and suggested groups for forest insect surveys. There is a vast wealth of information on the wide variety of potential methods for sampling insects. There is, however, a lack of good taxonomic keys with which to identify groups. We leave it to the individual groups to take a good deal of initiative on establishing specific monitoring objectives and methodologies in this section.

Data Analysis: Data analysis will depend on the amount of data submitted to ForestWatch, but we presume that few individuals will take the additional time to monitor forest insects. We recommend using these groups independently and track trends in species diversity and population densities of the censused taxa.

3.11 Protocol 3.2 Leaf Damage Profiles

Objective: Observe rates of damage to leaves of specific trees to gauge trends in the abundances of foliar herbivores in the forest.

Rationale: It is often difficult to catch and observe insects, but their sign is often quite visible and easily counted. Such is the case with foliar herbivores. There are several types of damage that are characteristic and readily observed. These include: leaf tissue consumption (chewed leaves), skeletonized leaves, mined leaves, leaf galls, leaf rollers. In addition, many symptooms of disease are readily viewed on leaves, such as spore cases, fruiting bodies and leaf discoloration. We classify leaf damage categories and ask participants to place a quadrat ring (a hoola hoop) over a portion of a tree canopy that is low enough to visually census. Volunteers then count damage on all of the leaves within this sample area. This is simple and readily doable.

We placed this protocol in the category three protocols, despite its relatively "clean" methodology, because we are uncertain of the value of the data that this will generate. Certainly we expect to see differences between the frequency of damage in each of the leaf damage categories for different tree species, forest types and bio-regions. But would this necessarily indicate a change in habitat quality? Similarly, were we to observe a temporal trend in a certain damage category we do not *a priori* know whether this trend indicates increasing forest health as a result of an increase in the ability of the forest to support insects, or decreasing forest health as

a result of either decreased predation on herbivores, or increased stress, and increased tree susceptibility. A pilot study would be required to determine whether there are likely to be trends, and whether there are discernible differences in damage levels in what we perceive to be high and low quality forests. Thus, more information is required in order to interpret the results of this protocol.

Data Analysis: Different damage categories are created by different groups of insects. We feel that, therefore, leaf damage categories should be tallied separately and analyzed individually. As above, the sparsity of data will probably require relatively simple measures of trends. Nonetheless, an effort to distinguish trends between forests that appear otherwise to be in good condition should be compared to those that otherwise appear in poor condition.

CHAPTER 4
POTENTIAL FORESTWATCH ADDITIONS

4.1 Fungal Monitoring

Field biologists in the Chicago region are currently working on measurement protocols for sampling mushroom diversity and fruiting body density. Fungi have recently come to the attention of conservation biologists owing to observations that populations may be declining on a global scale (e.g., Arnolds 1991). We have opted to omit this protocol because we are not equipped to adapt it to ForestWatch at this time. We recommend revisiting this problem at a later time as fungal monitoring protocols are further developed. Since many fungal fruiting bodies are readily identifiable, countable and common, this could be quite a good index of below ground forest status.

4.2 Lichen sampling

A lichen is an association of a fungus and an algae that results in the formation of a single living entity that we name as species. There are over 3500 lichens identified in North America and more than 200 in Illinois. Lichens are found growing on a variety of substrates, including rocks, bare ground, wood, and numerous other surfaces. The body of a lichen is called the thallus. Lichens, in general, are observed to be sensitive to pollution damage (e.g., Pfeiffer and Barclay-Estrup 1992, Scott and Hutchinson 1990). A monitoring protocol for sampling density and diversity (morpho-species) on tree trunks could provide additional information on pollution damage within forests. The development of such a protocol is considered worthwhile at this time. Test implementation will proceed without such a protocol. We recommend that this protocol be linked with canopy damage measures (protocol 2.2d). An individual with specific expertise in lichen identification needs to be contacted in order to develop this protocol.

4.3 Deer browse intensity

Anderson (1994) measured a gradient in the height of white trillium (*Trillium grandiflorum*) associated with differences in deer browse intensity in northern and central Illinois. Owing to the observations that deer populations have dramatically increased during the past 30 years, it is of considerable interest to monitor the use of various forest habitats by deer. This protocol would include a simple measure of mean plant height for anywhere between 50 and 100 haphazardly located individuals within a site. This is a secondary measure of deer population numbers. Deer populations are already tracked through harvest censuses. Thus, this protocol

would not provide information regarding deer populations that isn't already more accurately provided elsewhere. Nonetheless, this measure could be used to gauge habitat use, and habitat damage, by deer. Owing to the potentially large negative impact deer have on forested habitats this measure is recommended for consideration under any revision of ForestWatch.

4.4 SI/MAB 1 hectare forest mapping

The Smithsonian Institute and the Man and the Biosphere (SI/MAB) program are advocating a forest mapping project that would track forest dynamics through time within 1 hectare mapped plots (Dallmeier 1992). After considering a mapped plot option for ForestWatch it was decided that a mapped plot, although useful for determining long term trends in forest dynamics, would be unadvisable. We arrived at this decision because a mapped plot is very time consuming to establish, requires specific mapping tools, and requires thorough tree identification skills. Further, the information it contributes to our specific objectives are relatively sparse.

The same forest structure measures and dynamics can be tracked through the described permanent transect samples. Nonetheless, we believe that the SI/MAB protocols are advantageous for some uses (i.e., determining specific tree growth and recruitment rates). Further, a mapped plot provides a structure upon which to develop spatial components of other sampling methods (e.g., for birds). Ambitious participants may layer SI/MAB's mapped plot protocols on to the ForestWatch transects.

A program being established in Canada that is adapting SI/MAB protocols for schoolchildren suggests beginning with a single 25 m by 25 m plot and gradually adding 15 additional adjoining plots to complete the 1 hectare (100 m by 100 m) plot. Schools are not allowed to sample only a partial mapped plot. Once 6 mapped plot squares have been completed (3750 m^2) these may be substituted for the six 100 m by 6 m transects (3600 m^2).

4.5 Final Note

The aforementioned established protocols represent a large amount of data collection. We also add several additional suggestions to the list in this chapter. We recommend that if the existing protocols work out well and the program wishes to include some of these additional methods that some protocols shift to be completed in alternate years. Many protocols, such as the forest composition, are not expected to change dramatically from year to year. These could be done less frequently. Thus, schools may opt to survey two sites and visit them in alternate years, or ForestWatch could add more protocols and only require schools to complete a portion of them each year. Below is a list of protocols that we recommend placing into the annual and biennial sampling regimes if that strategy is adopted (Table 4.1).

Table 4.1 Annual and biennial sampling recommendations for existing and proposed ForestWatch protocols.

Annual	2.2a Non-native sp.	2.2c. Animal life	2.2d Tree health	Fungal density	Lichen sampling
Biennial	2.1 Forest Structure	2.2b. Habitat Complexity	2.2e. Dist. Sensitive sp.	2.2f Human use	Deer Browse

CHAPTER 5
RIPARIANWATCH

RiparianWatch is being developed because many of the appropriate sampling sites are in floodplains and gallery forests that are too narrow to qualify under ForestWatch. Riparian zones give rise to two problems that require a special addenda to ForestWatch. First, riparian forests will frequently be too wet to sample during spring school months as envisioned under ForestWatch. Thus, we develop bottomland forest sampling procedures as a Fall activity. Second, owing to the different season, and the different habitat, a large number of target species for forest characterization, the disturbance sensitive species and non-indigenous species identifications will change.

5.1. Protocol 1. Characterizing the Site

Objective. See Forest Watch Monitoring Protocols, Section 3.1

Rationale. In general, the rationale this protocol in RiparianWatch is the same as that for ForestWatch. In this protocol changes were made to accommodate for characteristics of the site that are due to the flow of the river. The students will be able to determine the flow rate and changes in flooding conditions of the stream or river if the teacher chooses to include this in the protocol. In addition, they will use topographic maps and satellite images to determine where the river or stream might be dammed or rerouted. Library research can also be used to supplement their findings. This information will allow the RiparianWatch to assess correlations between trends in riparian forest health and water flow changes.

A web page address is given to the teachers in the teacher manual. The teachers may access this site to obtain the names of the gauge stations near their site, the number of the gauge station, the datum and stages of the river/stream and streamflow rates. Also included in this web site are graphs water levels over a weeks period, maps of the areas surrounding the gauge station and historical records on the stages of the river. If all schools had access to the world wide web, this would have been included as a permanent part of the protocol. In the case where only the instructor has access to a the web, they may find the gauge station near the site and give the phone number to the students who may call and obtain the information. According to Vernon Knapp, author of "Streamflow Conditions, Flooding and Low Flows" in the CTAP publication (DENR 1994), these are the only avenues by which lay people can obtain daily records on river/stream condition.

Data Analysis. See Forest Watch Monitoring Protocols, Section 3.1

5.2. Protocol 2. Monitoring Transects

Objective. See Forest Watch Monitoring Protocols, Section 3.2

Rationale. As in ForestWatch, the primary goal of RiparianWatch is to characterize changes in habitat quality through time in a large number of sites (see ForestWatch, Section 3.2). To this end, the habitat sampling rationale and general transect establishment protocols are similar to those of ForestWatch. Changes were made, however, in the structure of the transects. Riparian forest sampling transects are often set parallel to the water's edge. In contrast, RiparianWatch transects are laid perpendicular to the water's edge, and the 100 m transects can be broken into smaller sub-transects. This was done to maintain a transect of sufficient length for each group's sample while maintaining groups in close proximity to facilitate coordination. Laying the transects end to end, parallel to the water, would spread the students over a long distance making it difficult for the coordinator to supervise the groups. To allow for some flexibility the transects are permitted to be 80, 90 or 100 m long instead of the required 100 m in ForestWatch

Each transect or sub-transect is to begin 5 m from the water's edge. This number was chosen arbitrarily for the sake of uniformity and is assumed to allow enough space for yearly variance in the water level. Transect stakes, however, may be flooded or covered by debris on occasion and this 5 m distance may be altered to fit site characteristics (e.g. dense impenetrable shrubs along a shoreline). Because transects (or sub-transects) are only 10 m apart and not likely to be independent samples, calculation of variance would be statistically inappropriate. Therefore, data for each response variable collected from all transects will be pooled and the mean for each site determined.

Data Analysis. None.

5.3. Protocol 3. Measuring Forest Structure

Objective. See Forest Watch Monitoring Protocols, Section 3.3

Rationale. The rationale for including this protocol as part of RiparianWatch is the same as that for ForestWatch (see section 3.3). Changes were made only in the species list. Nine genera of trees (maple, oak, elm, ash, walnut, hickory, beech, sycamore and cottonwood) were chosen for identification in RiparianWatch. Pine, which was included in ForestWatch, was excluded in RiparianWatch as it is not found in bottomlands. Sycamore and Populus were added. Only vegetative characters will be used to identify the tree species as the species will not be in a reproductive state simultaneously. This poses a problem for bottomland oaks. Three oak species found in floodplains, *Quercus virginiana, Q. laurifolia and Q. phellos*, are unlobed and cannot be easily identified without using other vegetative characteristics and fruits. Since we cannot be

sure that the trees will be in fruit when the students are working at the site the oaks with entire leaves will be distinguished from sycamores using bark and leaf pubescence. We try to minimize this problem, however, as the card on oaks explicitly alerts the students to the fact that some riparian oaks are unlobed and a drawing has been added for clarification.

In addition to the oaks, the identification of box elder may cause some confusion. Box elder, a maple, has compound leaves and may be confused with ashes. Again, warnings are placed on the identification cards with this potential confusion in mind.

Willows (*Salix* spp.) were not included in this activity as they grow in a highly branched manner which makes comparisons with other tree species difficult. Measurement of the trunk diameter requires a completely different set of protocols and data analysis. These species may be added later in a separate protocol.

Data Analysis. As in section 3.3

5.4. Protocol 4. Non-Native Species Survey

Objective. As in section 3.4

Rationale. The rationale for conducting this protocol is the same as that for ForestWatch (see section 3.4). Changes were made only in the species list. Five species and two genera of non-native species were chosen for this protocol (Garlic Mustard, Moneywort, Beefsteak Plant, European High-bush Cranberry, Multiflora Rose, Buckthorn, Honeysuckle). Students in each group will be required to be "experts" on either two taxa of bushes or three taxa of herbaceous species.

These species were chosen for the same reasons as those given in section 3.4. and because they are found in lowland forests. The Critical Trends Report was used to determine which species were most problematic in Illinois. This list was then narrowed to only those that are widespread and occur regularly in riparian habitats. All of these taxa should be readily found and identified by amateurs. As in ForestWatch, voucher specimens may need to be submitted if problems in identification of the species occurs.

Data Analysis. See section 3.4

5.5. Protocol 5. Habitat Complexity

Objective. As in section 3.5

Rationale. As in section 3.5

Data Analysis. As in section 3.5

5.6. Protocol 6. Animal Life

Objective. As in section 3.6

Rationale. The rationale for conducting this protocol is the same as that for ForestWatch (see section 3.6). Some species were added, and others deleted, due to the difference in habitat. Naturally, vipers were left out due to their inherent dangerous nature. The students may, however, come into contact with these species. To select species to be included The Illinois Natural History Survey publication on amphibians and reptiles (1986) was used. For both salamanders and snakes only those species that had a somewhat wide distribution (at least over half the state) and are common were chosen. The Red-backed salamander (*Plethodon cinereus*) was removed as it prefers drier habitats and has a rather restricted distribution. The Small-mouthed (*Ambystoma texanum*) and Eastern Tiger Salamander (*A. tigrinum*) were added as they frequent wetter habitats. For the same reason, the worm snakes (*Carphophi amoenus*), Ringneck (*Diadophis punctatus*), Eastern Hognose (*Heterodon platyrhinos*), Ribbon (*Thamnophis sauritus*), Red-bellied, (*Storeria occipitomaculata*), Graham's Water *(Natrix grahami*) and Bread Banded Rat (*N. sipedon*) snakes were added.

Data Analysis. As in section 3.6

5.7 Tree Health

This module was removed from RiparianWatch because forests will be sampled in the fall when leaves are senescing and falling off trees. Thus, it would result in variable results that are as dependant on the phenology of the year and sampling date as the condition of the site.

5.8 Protocol 7. Disturbance-Sensitive Species Survey

Objective. As in section 3.8

Rationale.The rationale for conducting this protocol is the same as that for ForestWatch (See Forest Watch Monitoring Protocols, Section 3.4). Changes were made only in the species list. Only Yellow Trout Lily and Maidenhair Fern are still included in RiparianWatch. Blue Cohosh, Small Bellwort, Doll's Eyes, White Trillium and Bleeding Hearts were removed from the

disturbances sensitive species list and Monkey Flower (*Mimulus alatus* and *M. ringens*), Blue-eyed Mary (*Collinsia verna*), Wild Petunia (Ruellia strepens), Bluebells *(Mertenzia virginica*) and Buttercups (*Ranunculus recurvatus*) were added. The Spiderwort species used in ForestWatch was changed to one more commonly found in lowland forests *(Tradescantia subaspera*).

These species were chosen for the same reasons as those given in Section 3.8 and because they are found in lowland forests. The Critical Trends Report was used to determine which species are most sensitive to disturbance in Illinois (DENR 1994). This list was then narrowed to only those that occur regularly in riparian habitats. Naturally, these species are somewhat uncommon and any one location may contain only a few of the species on the list. Only species suggested to be widespread in the state were used for RiparianWatch. As in ForestWatch, voucher specimens may need to be submitted if problems in identification of the species occurs.

<u>Data Analysis</u>. As in section 3.8

5.9 Protocol 8. Human Use

<u>Objective</u>. As in section 3.9

<u>Rationale</u>. As in section 3.9

<u>Data Analysis</u>. As in section 3.9

5.10 Protocol 9. Insect Census

<u>Objective</u>. As in section 3.9

<u>Rationale</u>. As in section 3.9

<u>Data Analysis</u>. As in section 3.9

5.10 Protocol 9. Leaf Damage Profiles

<u>Objective</u>. As in section 3.9

<u>Rationale</u>. As in section 3.9

<u>Data Analysis</u>. As in section 3.9

CHAPTER 6
PRAIRIEWATCH

6.1 Protocol 1.1: Characterizing the Site

Objective. This protocol uses topographic maps, aerial photos, land ownership, and the INAI database to characterize the physical and political features of the site. The purpose of this information is to allow sites to be grouped by similarities in key groups for analysis.

Rationale. At present we envision a classification of sites as outlined in Table 6.1. Classification measures may be analyzed singly or, if sample sizes allow, in conjunction with other classification measures (e.g., small publicly owned sites vs. small privately owned sites). The purpose of this categorization is to allow EcoWatch to distinguish trends in particular response variable(s) that may differ between sites with differing characteristics. It is possible to underestimate, or miss altogether, important trends in habitat quality as a result of trends moving in opposite directions in sites that vary in some key characteristic (e.g., a rare plant species declining in southern Illinois while increasing in northern Illinois). Given the limited number of prairie sites available to sample, we envision a reduction of analysis measures such that not all variables are analyzed in all possible combinations contrasted among all possible site classification schemes. Sample sizes would simply not permit such a comparison. It seems prudent to use a minimum cut-off of at least 5 sites of any one type to characterize a set of sites. Detailed analysis of specific response measures or combinations of classification variables would be done as specific hypotheses suggest them (i.e., if woody invasion is thought to be more pronounced in one natural division than another or more on lands under private than public ownership).

Data Analysis. The variables listed in Table 6.1 represent grouping variables for analysis of response variables. For the most part these are self-explanatory variables characterizing the region or the site. It is not clear how surrounding land use may impact prairie health, particularly between various rural categories (e.g., pasture, crops, or forests).

Table 6.1. PrairieWatch site classification variables

Categorization	Divisions used for contrasting forest response (number of units)	
1. Region	Northern, southern, and western edges, central Illinois	4
2. Natural Division	The Natural Divisions of Illinois (Schwegman et al 1973).	14
3. Land Ownership	private, public, dedicated nature reserve	3
4. Tract size	acreage	C
5. Surrounding land use	Forest, pasture, cropland, residential, commercial	C
6. Topographic position	upland, bottomland	2
7. Topography	flat, rolling, even slope	3
8. Dominant grass species	e.g., big bluestem, Indian grass, prairie dropseed	~6
9. Soil type	e.g., sand, silt-loam, loess, dolomite	~5
10. Stand Management	grazed, burned, mowed, none	4

C = continuous variable for which classes may be divided based on the distribution of sites.

6.2 Protocol 2.1: Assessing Plant Diversity

Objective. To assess a general level of plant biodiversity within prairie sites.

Rationale. Habitat diversity is a critical component in determining trends in the quality of prairie environments. PrairieWatch contains two protocols that help to assess habitat diversity. The ratio of grasses to forbs (Protocol 2d) assesses important habitat diversity changes as does the number of species per meter square (this protocol). While a directional trend in the ratio of grasses to forbs may indicate increasing or decreasing habitat diversity or habitat quality, an observed reduction in morpho-species per meter squared is a clear signal of deteriorating site quality. A related attribute of the distribution of diversity is habitat patchiness. Changing habitat patchiness can be detected through changes in the slope of the species-area curve.

We anticipate that changes in species diversity would be slow and difficult to detect across any time span less than decades. Nonetheless, diversity is an important signal in changing habitat quality and perhaps the one signal in which we are most interested. This measure may be assessed either through the slope of the species-area curve on a log-log scale, or through the

number of plots needed to saturate the species richness score for the site. The primary objective of this protocol, however, is to track changes in peak species richness.

Data Analysis. Data to analyze from this segment are two general measures. First, we are interested in the asymptote of the species area curve. This can be simply represented as the mean of the total number species observed by each team. Second, we are interested the patchiness of species within plots. This can be estimated using the slope of the species area curve on a log-log scale following the general form:

$$\log S = \log c + z \log A \tag{1}$$

where S = species richness
A = area sampled
c = intercept
z = slope of species-area curve

Alternatively, we can assess patchiness by estimating the mean number of plots required to reach a species count asymptote. While simpler, this measure may be difficult to estimate causally based on the subjectivity of estimating when an asymptote is reached in many cases. A mathematical method for determining the value of an asymptote and whether the sampling density has achieved this asymptote is available. By using a bootstrapped re-sampling of the data from each sub-plot to create artificial species area curves based on the actual data, re-arranged in random order, one can predict whether the sample has adequately sampled diversity such that the asymptote has been reached. This is beyond the scope of the high school volunteer groups and remains in the realm of the EcoWatch data analyst. Using several test data sets, however, would verify whether the sampling intensity recommended by PrairieWatch is appropriate. A review of species-area curves and the implications of sampling for them is found in Pielou (1977, p285-290) or Meffe and Carroll (1994, p.243-246)

6.3 Protocol 2.2a: Invasive Non-native Plants

Objective. To record presence/absence and measure changes in density of critical non-native invasive plant species within Illinois prairies. Two of these species are grasses (Kentucky bluegrass and meadow fescue) and found on most Illinois prairies. Determining changes in the abundance of these species, however, is of critical concern for prairie management. The remaining species (sweet clover, Canada thistle, parsnip, and common teasel) are widespread in Illinois prairies and are good indicators of habitat quality.

Rationale. One of the key threats to natural habitats is biological pollution. Tallgrass prairie habitats are particularly prone to invasion by a wide array of woody and herbaceous species that were not historically characteristic of these habitats. Assessing changes in their abundances is

one of several key components for tracking changes in habitat quality through time. While literally hundreds of vascular plants inhabit Illinois roadside habitats, only a small subset of these ever become established in high quality prairie remnants. Systematic collection of the changes in abundance of these species will provide a unique regional measure of habitat quality in Illinois prairies. Species are identified by simple pictorial guides and are chosen for their ease of identification as well as the threat they pose to prairies. For each species we track presence/absence with each site, the extent of infestation, and the density of plants within patches. These three measures are used assess changes in habitat condition.

Data Analysis. Data may be analyzed on a species by species basis to assess changes in the extent or density of species. Extent is expressed as a proportion of all transect segments in which the species is found. Density is the expressed either as the mean density observed in transect intervals where the species is located (within patch density), or the mean density for all sampled transect segments (site density). Alternatively, the presence of non-indigenous species may aggregated into one measure by summing scores for all target species. In this case, site density acts as a combined measure of frequency and patch density. For sites where presence is recorded, but no single transect segment contains the target plant, the site score becomes a 0.001. This equivalent to a measure density of a single plant found within 25 transect segments (250 x 4 m).

6.4 Protocol 2.2b: Invasive Woody Plants

Objective. To measure the density of woody inhabitants, and in particular woody invaders, of Illinois prairies.

Rationale. Increasing density of woody species on Illinois prairies is probably the single most clear indication of degrading habitat quality. This prairie habitat degradation occurs in sites where fire, mowing, or grazing disturbances have been eliminated such that prairies slowly change to forest. High quality prairies, however, do contain a component of native prairie flora that is woody. Thus, students are instructed on methods to count and distinguish woody species density into native and non-native components. Having done this, EcoWatch can then analyze changes in these two important woody species components of the prairie flora. The single most obvious driving force that may change the density of woody stems is a change in fire frequency. Instigating a fire management regime in an area not previous systematically burned can cause a temporary increase in the density of stems as top killing woody invaders often leads to an increased number of sprouts. With continued fire management, however, these woody invaders should gradually decrease. Thus, brief sharp increases in woody species density must be interpreted with caution. Sustained increases in woody species density however are a clear sign of prairie degradation.

Changes in the density of woody native prairie species is more difficult to interpret. These woody species characteristic of prairies (e.g., *Rhus glabra, Ceanothus americanus*) can also

increase in prairies that are degrading, or succeeding into woodlands. These species, however, tend to be swamped in abundance by non-prairie species (buckthorns, dogwoods, oaks and maples) in unburned prairies. Thus, an increase in native woody species, along with a decline in non-prairie woody species, would be interpreted as a good sign. Decreasing density of native woody prairie species associated with an increasing density of non-prairie woody species would be a sign of declining prairie health.

Data Analysis. In this case we expect the presence of at least some native and non-native woody plants on all sites. Even in very high quality prairies occasional establishment of a species more typical of forested habitats is expected. We suggest creating two simple measures using data from this protocol. First a mean density of native woody plants characteristic of prairies. Second, a mean density of non-prairie woody plants. These can be tracked through time as simple measures of density (mean number per plot). A ratio or the two densities would provide a single value that would be a good measure of prairie health, where a high prairie to non-prairie species would be good and a low ratio would be bad. This, alone, however is not sufficient and would need to be accompanied by an estimate of total density of woody plants.

6.5 Protocol 2.2c: Disturbance-Sensitive Plants

Objective. Record the presence (and density) or absence of six species of plants sensitive to human disturbance (pale coneflower, leadplant, green milkweed, prairie dropseed, prairie clovers, and gentians). Annually recording this information will detect changes in the distribution and abundance of these plants and will help biologists assess whether conditions for native plants are improving or deteriorating in Illinois prairies.

Rationale. One of the key indicators of degrading prairie health is the loss of disturbance intolerant species. These species may be extirpated from a prairie through mechanical disturbances such as grazing and mowing; or from changed disturbance regimes such as fire suppression and mesophytic succession. One of the most rapid and obvious degradation that will occur through fire suppression is woody species invasion and will be measured directly elsewhere (protocol 2.2b). In particular, we feel that these indicators will most proximally detect degradation as a result of cattle grazing disturbance or excessive deer browse activity.

On a state-wide basis, the historical records from which we may glean a past distribution are typically limited to presence data based on collection dates and locations of herbarium and museum collections. These data are not sufficient to estimate the magnitude of the impact of habitat loss on the dynamics of disturbance-sensitive species, changes in the distribution, per se, or changes in abundance within sites. In this protocol we have chosen several disturbance-sensitive species based on: 1) their presence in high quality prairies; 2) an observed propensity for extirpation with disturbance; and 3) because they are readily identifiable and not easily confused with similar taxa. We focus on plants because they are much easier to monitor from

year to year. In this case, identification does not rely on a taxonomic key because the numeric majority of species would be classified as "other". Instead we rely on pictorial examples with key characteristics highlighted. One question for initial implementation is whether this is sufficient for accurate identification.

For each of the six target species we strive for three pieces of information from the data collected by volunteers. First, by surveying the prairie in general we attempt to identify presence or absence of a taxa within a site. Second, by repeatedly identifying presence/absence within each 10 m section of transects we can determine whether a population is expanding in extent within a particular site. Third, by recording a measure of density within a circle of 2 m radius we assess whether population density is increasing within habitat patches in the prairie. To measure density we have devised a method that is as economical as possible. Within each 10 m interval along sample transects volunteers will count presence or absence. Next, volunteers count the number of plants in a circle with a radius of 2 m. If the population is very dense, then the volunteers merely calculate the proportion of the circle (and hence the area) occupied by 100 individuals. This measure is then converted to an estimated density. For this switch to remain valid volunteers must not choose the most dense, or most convenient, patch in which to measure area, but begin at a random point such that we can treat the data as an unbiased, even if occasionally unrepresentative, sample. Hence, volunteers use a flag toss over their shoulder to locate the plot center.

Finally, many plants may be in low densities, or patchily distributed such that they are not found within plots. The final task of volunteers is to scan the entire prairie (or the 2 ha segment being sampled by PrairieWatch) for the presence of uncounted species. The volunteers then map these occurrences. A revision of PrairieWatch will want to analyze whether there are too many instances of no data such that it may be preferable to include a specific task to search for, and then quantitatively sample, known patches. The problem, of course, is that this method can document decreases in density through population losses, but cannot track population increases through new establishment. Thus, some sort of random, or stratified repeated sampling of specific sites is required even if most plots return data values of zero abundance.

Data Analysis. These data may be analyzed in two ways. First, and most importantly, changes in regional extent, extent within prairies and density within prairies may be analyzed species by species. These analyses may be lumped for the whole state or considered by any site classification combination. Secondly, an overall variable may be constructed by summing an importance value type of measure for each disturbance-sensitive species within a site. Importance values are constructed by averaging frequency, density and basal area measures for trees. In this case, occurrences will be weighted by the frequency of transect segments occupied and the density within each segment to obtain a score for each species. We suggest following the logic of Daubenmire's modification of the Braun-Blanquet cover class system by scoring a 1 for site presence outside of the transect, and a score of 2-6 within each occupied segment based on the density within occupied circular plots as follows: 2 = 1-5 plants within the plot, 3 = 5-25 plants

within the plot, 4 = 25-100 plants within the plot, 5 = 5-25 plants/m^2, 6 = >25 plants/m^2. Five plants per square meter equals 100 plants segment. Site scores equal 1 (the minimum value to indicate presence) plus the mean segment score. All species scores can be summed to gain an overall measure of non-native species impact within a site. Values for each species, as well as an aggregate score are recorded through time within sites.

6.6 Protocol 2.2d: Assessing Prairie Grasses

Objective. To assess changes in prairie habitat through time by examining the structural component of the prairie through the grass to forb ratio and grass seed output.

Rationale. Systematic changes in species composition are often a result of environmental degradation. Prairies exhibit a wide array of types from those dominated almost exclusively by broad-leaved herbaceous species (forbs) to those strongly dominated by grasses. For example, Weston Prairie (McClean County) is strongly dominated by forbs, while Loda Prairie (Iroquois County) is relatively more strongly dominated by grasses. These differences are readily apparent to the eye when visiting these sites. Yet both are mesic black soil prairies with over 100 species of vascular plants and rated in good to excellent condition by the Illinois Nature Preserves Commission (McFall and Karnes 1995). Thus, there need not be a specific ratio that is to be strived toward through prairie management, but a mixture is clearly a sign of a healthy prairie. With fewer than a dozen species of prairie grasses in most high quality prairies, the vast majority of plant diversity are forbs. Similarly, forbs most likely generate a higher rate of plant-nonplant interactions with relatively specialized herbivores and pollinators. Finally, spring and fall fire management often favors the propagation of grasses at the expense of forbs. Howe (1994a,b, 1995) suggests that historically grasslands were probably characterized by summer fires that promoted herbaceous forbs at the expense of grasses. Current fire management, owing in part to the relative inability of native Illinois prairies to burn during summer, favors grasses. Thus, temporal trends where forb densities decrease would imply a degradation of the prairie ecosystem.

A common problem with grasses is that they are often stimulated to produce flowering stalks, but often do not fill their seeds. A prairie may seem healthy when populated by numerous grasses with seed heads, but be in a state of decay as a result of a lack of actual seed production. We have proposed to sample grass heads for actual seed production as a check for a potential source of prairie degradation. Volunteers are instructed to examine seed heads to measure the proportion of seed heads filled with seed. Seed production may vary substantially from year to year, and cool wet weather at just the right time of year can cause many grasses to fail to fertilize their ovules. A single year of uniformly poor seed production should not be viewed as a serious source of environmental degradation. Repeated failure of grasses to produce seed, however, would indicate deteriorating conditions for grasses.

Data Analysis. We suggest using relative simple measures as response variables. A simple ratio of grasses to forbs can be constructed for both center and edge plots. We expect the forb ratio to be higher along prairie edges owing to introduced roadside weeds. In addition, a simple tabulation of seed productivity for two dominant prairie grasses (big bluestem, *Andropgon gerardii*, and Indian grass, *Sorghastrum nutans*) would indicate temporal trends in habitat quality. These response variables may be tabulated at the site level, the bio-region or state-wide.

6.7 Protocol 2.2e: Reptiles and Amphibians

Objective. To assess habitat usage by selected vertebrate groups. In particular, reptiles and amphibians provide easy countability because of their propensity to hide in cool dark places during the day. These data are made more valuable, however, by the fact that amphibians are reputed to be declining globally as a result of air pollution. These data will allow ForestWatch volunteers to assess the status of amphibians within Illinois.

Rationale. A subset of reptiles, amphibians and mammals are readily detectable and provide a measure of faunal diversity or faunal activity in a prairie. There are few measures of vertebrate diversity that are possible to measure with a large group of untrained biologists. This protocol was chosen because it partially fills the need to account for such species. This protocol is not meant as a choice to select the most ecological meaningful vertebrates, or those that may be most indicative of vertebrate diversity as a whole. Reptiles and amphibians simply possess a life history that allows them to be counted through the careful placement of boards that provide hiding places for these organisms. Since many species will sit and wait under a board, they are easily counted by untrained observers. Weather conditions may alter the ability of volunteers to count these organisms in that some species are more likely to be mobile during cool, wet periods. Others will sun themselves on warm, dry days. Thus, weather conditions may be an important factor in observation density and ought to be analyzed early on to estimate an effect size of weather. In appreciation of the effect that weather may have on the observation of these faunal groups, volunteers are asked to record cloud cover, general humidity conditions, approximate temperature and approximate wind speed.

Species for this protocol are based on Smith (1986) and advise from Dr. Chris Phillips (Illinois Natural History Survey).

Data Analysis. Within the first few years of PrairieWatch data collection data analysts should conduct two data veracity checks. First, assess the effect of weather conditions on observation rates. Second, attempt to verify species identifications by collecting either sample photos of specimen observed from the volunteer groups, or re-visit sample sites to sample the study area with qualified experts. Species identification should be straight-forward, but would be essential to verify for the purposes of data quality control.

Since the density of observations is expected to be low, we suggest that the most appropriate response variable would either be total number of individuals and total number of species observed. These would probably need to be lumped across many sites since sites may more often than not result in zero observations in any given year.

6.8 Protocol 2.2f: Landscape Integration

Objective. To gauge the degree to which the prairie site participates in an integrated ecosystem with the surrounding land. Observe visible signs of prairie activity, including past and present human impacts that may affect prairie quality. Regularly recording this information on the level of human impact and on how well one can perceive animal use of a prairie allows biologists to assess habitat in terms of human and animal use.

Rationale. As in ForestWatch protocol 2.2f, we inserted this segment partially to allow volunteers a unit to enhance their appreciation of how severely our natural habitats are impacted by humans. Everywhere signs of human impact are visible within Illinois' prairies. From cats meandering through a prairie, to the noise from automobile traffic and adjoining land use, signs of degradation are everywhere. This segment is also designed to enhance the volunteers appreciation of how can "read" the history of a stand and current impacts by examining the site for signs of trails, refuse, pets, old cemetery plots, or railroad rights-of-way.

In addition, this protocol is used to assay the extent to which the prairie is integrated into its surrounding land use. We do this by observing the rate at which things (birds, butterflies, dragonflies, etc) move into and out of the prairie. This seems, even to us, a bit of a vague measure. We hope that we can make some sense out of it and differentiate movement rates between prairie and other types of habitats. In our casual observations of prairies, this seems like a measure that will generate many observations in that things are always moving in and out of prairies. The question remains as to whether these data are actually useful in measuring any attribute of interest. We feel that it will be because it provides an estimate for bird, butterfly and dragonfly density on the prairie. Even if these measures are not very specific in terms of species identifications, this information ought to be a crude measure of faunal activity on the prairie.

Data Analysis. We recommend simple data analysis of aggregated observations of numerous categories (cats, trash, etc.) Standardized by the variance observed across these potentially variable measures. For example, volunteers might routinely see an order of magnitude more cats than people. Thus, standardizing counts by their mean and variance across sites (see data standardization below) equalizes the weight of each variable. In contrast, retaining separate counts for different taxa coming and going across the prairie border is warranted as there are likely to be numerous observations of each, and they may reflect different attributes of a prairie.

6.9 Protocol 3.1: Bird activity

Objective. To count the number of birds, by species, observed on a prairie. These counts include both visual sightings and bird calls to identify individuals.

Rationale. Grassland birds have decline markedly during the past century as a result of clearing most of Illinois' pastures for row crops (Herkert 1991a,b). Many grassland birds require relatively large habitat patches. Counting bird occurrences in prairies will allow a better assessment of trends in bird density, as well as diversity. This information will also assist in better defining habitat patch size requirements for prairie birds. Many of the conservation arguments used to cite the need for large prairie restorations rest on the large habitat requirements of grassland birds, and their general population declines during this century. Thus, size has become an important consideration for prairie conservation. We need, however, more information on habitat usage of small prairies by birds. Further, casual observation suggests that many birds (e.g., crows, robins) use prairies shortly after they have been burned more than those that have not been burned for a while. This may result in extraordinarily high insect predation rates on freshly burned sites. Collecting systematic information on bird usage of prairies with respect to burn history will quantify this casual observation and, if verified, may lead to useful hypotheses about prairie insects and burn cycles. Unfortunately, these observations require a level of skill that is not commonly found among high school students. Thus, we relegate this potentially important measure to a part 3 activity.

Data Analysis. Depending on the extent to which various groups may actually collect these data fields, we recommend analyses that retain trends for species individually. Thus, data analysis would probably best be done over large geographic ranges and use mean or median numbers of observations per unit time of observation. Bird censusing data is very common under the auspices of the Christmas Bird Counts and the Breeding Bird Survey. These data sets are probably the most complete data set of faunal observations in North America. We recommend following their lead in data analytic techniques. A description of the Breeding Bird Survey is found in Robbins et al. (1986).

6.10 Protocol 3.2: Insect Surveys

Objective. To estimate diversity of prairie insects through the use of standardized survey methods such as sweep nets, visual surveys, pitfall traps, and visual surveys of galls.

Rationale: Invertebrates represent the largest proportion of above-ground diversity in terrestrial ecosystems. As such it is important to gauge the diversity of critical invertebrate groups. Assessing diversity, however, requires expertise that is probably above the level of the majority of the volunteers in this program. As a result, we have provided a skeleton outline of the preferred procedures and suggested groups for forest insect surveys. Others have argued that an

untrained person can sort most insects into morpho-species and end up predicting the species diversity of insects within a site. This may be true for Illinois as well. In contrast, Panzer et al (1996) argue that knowing something about an insect group allows one to determine whether the species observed are Eurasian exotics that inhabit all grasslands, high quality or not, or whether the insects are prairie dependent species of conservation concern. In general, we believe that counting densities of common, widespread species that do not depend on prairies for habitat is not terribly valuable. Thus, we prefer to focus sampling on suites of taxa with many species dependent on prairie plants. This requires specific expertise that is beyond the typical high school student, and thus we relegate this protocol to the optional tier of activities.

Data Analysis. Similar to bird surveys, analytic methods are best done within uniform taxonmic groups. Since data coverage is likely to be sparse and vary between groups, a simple analysis of diversity or density within sites is likely to be the extent of analysis available from this protocol.

6.10 Protocol 3.3: Ozone damage of milkweeds

Objective. To assess the level of plant damage sustained by plants as a result of ozone pollution.

Rationale. Air pollution can have severe effects on plant health in natural ecosystems. Several studies have examined the sensitivity of various plant species to ozone. Green milkweed displays characteristic sign of damage as a result of ozone pollution (Komroy et al. 1992, Stolte et al. 1992, Stolte and Mangis 1992). We do not know whether any of the other prairie milkweeds are sensitive to ozone damage, but the literature suggests that several milkweeds are sensitive to ozone damage (Konroy et al. 1992). Ozone plumes from industrial areas can be a common event and often cause severe damage to a wide array of plants. We suggest a survey of ozone damage to milkweeds because of documentation of the damage that occurs (Stolte et al 1992).

Data Analysis. Ozone damage is likely to be spatially variable and episodic. We suggest that the most meaningful analysis of trends in this measure would report the frequency of ozone damage incidents. We suggest using the first several years of data to gauge whether ozone damage is readily apparent in sites where it occurs (i.e. does it affect most target plants in a site when any demonstrate signs of damage?). Based on reports of the distribution of ozone damage and plant response, we suspect that damage will be widespread within a site, or non-existent. If so, we suggest scoring the widespread damage within a site in a particular year as a damaged sites. Then simply gauge the frequency within which certain sites sustain damage, and then do a trend analysis of the number of ozone damage incidents per year.

CHAPTER 7
POTENTIAL PRAIRIEWATCH ADDITIONS

7.1 Deer Browse

A potential source of severe degradation in prairies is through excessive deer browse. Roger Anderson (Illinois State University) is conducting an experiment at Goose Lake Prairie to assess the damage that a large deer herd can inflict on a natural prairie. We are not, at this time, prepared to write a protocol that would examine this damage systematically in Illinois prairies, although it would seem a simple and potentially useful protocol to have in the future. For example, we have obsered that deer frequently brose basal leaves of rattlesnake master (*Eryngium yuccifolium*) in the spring. This species is readily identifiable and easily censused for the degree of deer browse damage (i.e. proportion of plants with basal leaves chewed off). We suggest that this be incorporated when the results of Anderson's and others research become available.

7.2 Seedling recruitment, individual mortality estimates

All things being equal, small populations are more likely to go extinct than large ones. Therefore it seems reasonable that a critical concern regarding small preserves is the potential for loss of species diversity through time. As a result, conservation efforts have focused recently on acquiring large preserves. This problem is particularly acute in Illinois prairies owing to the fact that virtually all of the very high quality prairies are very small (DENR 1992, Robertson et al. 1997). Thus, large prairies require restoration, or enhancement of their biota's with native species. Small sites contain our reserve of this diversity. A key question of these small sites, however, is whether they are actually losing diversity through stochastic processes.

While EcoWatch volunteers are not going to be examining prairies in the detail required to answer this question directly, they could contribute to an answer by tracking individual establishment and mortality rates for key species. To do this we recommend that students permanently mark individual plants and then census them each year (or alternate years). Measures collected on these target plants would be survivorship, plant size and reproductive output. Concurrently, students could examine short transects to look for new plant establishment.

This protocol may seem very much like the one on disturbance sensitive plants, but the goals are somewhat different. Here we are looking to gain an estimate of individual life spans, and establishment rates, or population turnover. To accomplish this task we would choose

common prairie species (e.g., prairie dock, compass plant) that would allow ready identification.

7.3 Monitoring on Prairie Restorations

A critical concern of conservation biologists is whether prairie restoration sites are living up to expectations of refurbishing prairie diversity within Illinois (and elsewhere). We have avoided using restoration sites owing to the variable nature of restorations. Some restoration sites are, essentially, carefully manicured and managed gardens. These, typically have very high species diversity. Others are one time plantings that can hardly be called restorations. The majority are somewhere in between. The Fermi Lab restoration has been an attempt to reconstruct a prairie using techniques available such that large areas could be restored in this manner. Goose Lake Prairie and several other state owned lands are currently under restoration using mechanical means.

We recommend choosing a small set of sites, and a select suite of monitoring groups (i.e., volunteer groups or schools that demonstrate a high level of competence and enthusiasm for these monitoring programs) and assign them a variety of restoration sites for continual monitoring. Specific monitoring protocols could be very much like the ones for typical prairie sites, although it would be nice if these groups were able to identify species more carefully in order to keep a floristic composition list for their sites.

7.4 Savannas

Savanna habitats are particularly problematic in that they contain a suite of species that are not characteristic of prairies (Packard et al 1997). We decided, in doing ForestWatch, that placing savannas with prairies would be more appropriate than placing them with forests for monitoring. The definition of a savanna, however, remains somewhat problematic (Taft 1997). Thus, we recommend that after PrairieWatch has been established and tried in several test cases, that a select group of Chicago area schools or volunteers be used to implement PrairieWatch on a series of savanna sites. In doing thisa unique set of problems may arise. These groups will be responsible for detecting what these may be and how protocols may need to be changed to account for the presence of scattered trees along sampling transects, and a slightly different suite of plant species.

CHAPTER 8
WETLANDWATCH

Perhaps no other general ecosystem type has had as much environmental regulation or monitoring interest as wetlands (e.g., Kent et al. 1992, Adamus 1992, DENR 1994). We approached WetlandWatch with a great deal of trepidation owing to the fact that there are literally volumes written in the scientific literature on wetland delineation. Legal battles regarding the status of designated wetlands are famous. Anything that we offer as a wetland monitoring program will be assailed on some front if put to scrutiny by the appropriate parties. That said, we forged ahead and designed protocols along the same lines as in previous sections: with an interest in (a) structural complexity; (b) invasive species, (c) disturbance-sensitive species, (d) faunal diversity, and (e) human impacts. In this unit we place relatively more effort into measuring human impacts through tracking water quality.

8.1 Protocol 1 Characterizing the Site

Objective. This protocol uses topographic maps, aerial photos, land ownership, and the IWI (Illinois Wetland Inventory) database to characterize the physical and political features of the site. The purpose of this information is to allow sites to be grouped by similarities in key groups for analysis.

Rationale. Wetland sites need to be sub-classified in order to distinguish trends in habitat quality in sites that vary in key characteristics. At present we envision a classification of sites as outlined in Table 8.1. Classification measures may be analyzed singly or, if sample sizes allow, in conjunction with other classification measures (e.g., small publicly owned sites vs. small privately owned sites). The purpose of the categorization is to allow EcoWatch to distinguish trends in particular response variable(s) that may differ in sites with differing characteristics. It is possible to underestimate, or miss altogether, important trends in habitat quality as a result of trends moving in opposite directions in sites that vary in some key characteristic (e.g., a rare plant species declining in southern Illinois while increasing in northern Illinois). Given the limited number of wetland sites available to sample, we envision a reduction of analysis measures such that not all variables are analyzed in all possible combinations contrasted among all possible site classification schemes. Instead we envision an analytical approach of analyzing a summary response variable from each protocol by each of the classification measures (individually). More detailed analysis of specific hypotheses would be conducted as the data suggest them (i.e., if non-native invasion is thought to be more pronounced in one natural division than another or more on sites under private than public ownership).

Data Analysis. The variables listed in Table 8.1 represent grouping variables for analysis of response variables. For the most part these are self-explanatory variables characterizing the

region, or the site. It is not clear how surrounding land use may impact wetland health, particularly between various rural categories (e.g., pasture, crops, or forests), but runoff of pollutants is likely to vary between types of sites. Unlike ForestWatch, we don't envision rural agricultural impacts on wetlands to be less than residential or commercial land uses. We do, however, expect forest and pasture to be have fewer negative impacts on wetlands. Thus, we may consider a re-weighting of categories for wetlands to create a different type of surrounding land use score. For example, scoring a range between 0 and 5, depending on the prevalence of high impact sites close by and within the watershed of the wetland. High impact land uses would be those that are likely to create a nutrient enriched runoff into the wetland.

Table 8.1. WetlandWatch site classification variables

	Categorization	**Divisions used for contrasting wetland response (number of units)**	
1	Region	northern, southern, and western edges, central Illinois	4
2	Natural Division	The Natural Divisions of Illinois (Schwegman et al. 1973)	14
3	Land Ownership	private, public, dedicated nature preserve	3
4	Tract size	acreage	C
5	Surrounding land use	Forest, pasture, cropland, residential, commercial	C
6	Surrounding topography	flat, rolling, even slope	3
7	Wetland classification	The Illinois Wetland Inventory classification	~11
8	Percent open water	Greater or less than 50%	2

C = continuous variable for which classes may be divided based on the distribution of sites.

8.2 Protocol 2. Vegetation Zones

Objective. To assess general vegetation zones, as a coarse measure of diversity, within the site.

Rationale. Habitat diversity is a critical component in determining trends in the quality of wetland environments. Decreasing diversity of habitat zones through time is a natural process in wetlands as they gradually fill in. This process, however, is slow under natural conditions. Increased sedimentation rates are associated with increased nutrient status of wetlands, and hence increased biomass accumulation. Increased sedimentation is also associated with increased sediment loads of inflowing waters. Both are common problems that degrade wetland habitats. This protocol assesses habitat diversity by categorizing dominant plant types (rushes, shrubs, sedges, trees) into vegetation zones. Alternative causes of decreasing habitat diversity are also problematic. For example, a decrease in open water may indicate decreasing habitat quality if non-native species are causing the decrease. The primary objective of this protocol is to categorize vegetation zones and the amount of open water.

Data Analysis. Data to analyze from this segment are the number and types of dominant plants and the emergent vegetation as a percentage of the wetland (or the open water as a percentage of

the wetland). These can be tracked through time as measures of habitat diversity.

8.3 Protocol 3 Non-native and Invasive Plants

Objective. To measure the presence and density of several non-native and invasive plants.

Rationale. One of the key threats to wetlands that is not monitored well anywhere is the threat of biological pollution. We have lists of non-native and native species that are invasive to wetlands, general distributions of these species, but no formal way of assessing changes in abundance once species arrive in a region. In order to track habitat quality, we require an estimate of the magnitude of the impact of non-native and invasive species and their dynamics. In this protocol we have chosen several species of non-native and invasive plants based on: 1) their ability to invade wetlands beyond the wetland boundary; 2) a large purported impact on native wetland biota; and 3) their occurrence in specific wetland types. We focus on plants because they are much easier to monitor from year to year. In this case, identification does not rely on a taxonomic key because the majority of species would be classified as "other". Instead we rely on pictorial examples with key characteristics highlighted. In addition a website with photographs of these species provides information on the appearance in the field. A concern that must be addressed in initial implementation is whether these identification aids are sufficient for untrained volunteers to make accurate identifications. We may need to require submission of a voucher specimen from groups when they encounter a target species in order to verify identification.

For each of 15 target species we strive to obtain two pieces of information from the data collected by volunteers: population extent and population density. For this protocol we modified the 1994 protocol developed by the Maryland Compensatory Mitigation Guidance Task Force (comprised of eight federal and state agencies; Table 8.2) for transect establishment and vegetation measurement. These transects allow volunteers to measure our two objectives. First, transects measure of the patch size (length) for non-native and invasive plant species near transects. Second, by counting the number of non-native and invasive plant species in specific transect segments, relative densities can be calculated. This allows detection of whether population size is expanding within infected portions of the wetland. To measure density we have devised a method that is as economical as possible. Within each 10 m interval volunteers will count all individuals when a population is in low density. If a particular species is very dense, this could take an undue amount of time for little additional information. Instead the volunteers then switch to counting them as more than 100 individuals.

Table 8.2. Agencies comprising the Interagency Mitigation Task Force

U.S. Army Engineer District, Baltimore
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
National Marine Fisheries Service
Federal Highway Administration
Maryland Department of the Environment
Maryland Department of Natural Resources
Maryland State Highway Administration

Data Analysis. These data may be analyzed in two ways. First, and most importantly, changes in regional extent, extent within wetlands and density within wetlands may be analyzed species by species. These analyses may be lumped for the whole state or considered by an site classification combination. Secondly, a combined variable that estimates overall impact may be constructed by summing an importance value measure for each non-native or invasive species within a site. Importance values are constructed by averaging frequency and density measures by species. In this case, occurrences may be weighted by density within each transect segment to obtain a score for each species. We suggest following the logic of Daubenmire's modification of the Braun-Blanquet cover class system by scoring a 1 for site presence outside of the transect, and a score of 2-6 within each occupied segment based on the density within occupied segments as follows: 2 = 1-5 plants within the segment, 3 = 5-25 plants within the segment, 4 = 25-100 plants within the segment, 5 = 5-25 plants/m^2, 6 = >25 plants/m^2. Five plants per square meter equals 100 plants per segment. Site scores then equal either 0 (complete absence) or 1 (the minimum value to indicate presence of a species) plus the mean segment score. All species scores can be summed to gain an overall measure of non-native and invasive species impact within a site. Values for each species, as well as an aggregate score for all species combined, are recorded for each site.

8.4 Protocol 4 Disturbance-Sensitive Plants

Objective. Record the presence (and density) of 42 species of plants sensitive to human disturbance. Recording this information on an annual basis will allow detection of changes in the distribution and abundance of these plants. This information will help biologists assess whether conditions for native plants are improving or deteriorating in Illinois.

Rationale. One of the key indicators of degrading wetland health is the loss of disturbance intolerant species. These species may be extirpated from a wetland habitat through mechanical disturbances such as grazing or drainage of a wetland; or from changed disturbance regimes such as mesophytic succession; or from competition with non-native species. In practice, however, we rarely track the distribution of these species in anything more than a vague sense (i.e., we note which ones are now threatened or endangered with extirpation within the state), but have no formal way of assessing the frequency of species losses, or changes in abundances, within sites.

The historical records from which we may glean a past distribution are typically limited to collection dates and locations of herbarium and museum collections. These data are not sufficient to estimate the magnitude of the impact of habitat loss on the dynamics of disturbance-sensitive species. In this protocol we have chosen disturbance-sensitive species based on: 1) their presence in high quality wetlands; and 2) an observed propensity for extirpation with disturbance. We focus on plants because they are much easier to monitor from year to year. In this case, identification does not rely on a taxonomic key because the majority of species would be classified as "other". Instead we rely on pictorial examples with key characteristics highlighted. In addition a website with photographs of these species provides information on the appearance in the field. A major concern that must be addressed in the initial implementation phase is whether we have posted too many species for volunteers to practically measure and whether our identification aids are sufficient to allow volunteers to make accurate identifications. We may can assess these concerns by asking for a submission of voucher specimen from groups when they encounter a target species. Re-evaluation after initial implementation, along with constraints of time spent managing the data by DNR, will direct a decision on whether to continue to require voucher specimen from all groups on their first visit to sites.

Similar to non-native species, we are seeking two pieces of information from the data collected by the volunteers. First, by identifying presence/absence within each 10 m section of transects we determine whether the population is expanding in area within a site. Second, by recording a measure of density within each 10 m section we assess whether population size is expanding. To measure density we have devised a method that is as economical as possible. Within each 10 m interval volunteers will count all individuals when a population is in low density. If a particular species is very dense, this could take an undue amount of time for little additional information. Instead the volunteers then switch to counting them as more than 100 individuals. This measure can then be converted to an estimated density over the 10 m transect segment. For this switch to remain valid volunteers must not choose the densest, or most convenient, patch in which to measure area, but begin at a set point (i.e., the beginning end of the 10 m transect segment) such that we can treat this as an unbiased, even if occasionally unrepresentative, sample.

Data Analysis. These data may be analyzed in two ways. First, and most importantly, changes in regional extent, extent within wetlands and density within wetlands may be analyzed species by species. These analyses may be lumped for the whole state or considered by an site classification combination. Secondly, a measure of overall impact may be constructed by summing an importance value for each disturbance-sensitive species within a site. Importance values are constructed by averaging frequency and density measures by species. In this case, occurrences may be weighted by density within each transect segment to obtain a score for each species. We suggest following the logic of Daubenmire's modification of the Braun-Blanquet cover class system by scoring a 1 for site presence outside of the transect, and a score of 2-6 within each occupied segment based on the density within occupied segments as follows: 2 = 1-5 plants within the segment, 3 = 5-25 plants within the segment, 4 = 25-100 plants within the segment, 5

= 5-25 plants/m^2, 6 = >25 plants/m^2. Five plants per square meter equals 100 plants per segment. Site scores equal either 0 (site absence) or 1 (the minimum value to indicate site presence) plus the mean segment score. All species scores can be summed to gain an overall measure of disturbance-sensitive species impact within a site. Values for each species, as well as an aggregate score are recorded through time within sites.

8.5 Protocol 5 The Abiotic Environment

Objective. This protocol provides directions for sampling substrate, water chemistry, turbidity, and water flow in a wetland with open water.

Rationale. Several important attributes of site quality are measured from the abiotic conditions of the site. Sampling for such abiotic conditions are standardized procedures in many wetland sampling programs. The sampling designs for this protocol came either directly, or with modification, from a manual written for volunteer sampling of rivers and streams associated with the monitoring program linked through the Global Rivers Environmental Education Network (GREEN). The manual (Mitchell and Stapp) and the complementing Field Manual for Global Low Cost Water Quality Monitoring (Stapp and Mitchell 1995) are available from:

GREEN Office
721 E. Huron
Ann Arbor, Michigan 48104.

These sampling designs were written for volunteers with low expertise and funding to start an environmental sampling program in a watershed. Each site will be repeatedly sampled (across years) at locations that will be marked on site maps. Data will be collected at sample locations of the following: substrate type (five categories), water chemistry (dissolved oxygen, pH, conductivity or salinity, ammonia, nitrate, nitrite, alkalinity, phosphate, temperature, and turbidity),water flow (direction and rate), catchment area. Substrate can be examined over time for changes that indicate degradation (increased sediment). Water chemistry parameters, water flow direction and rate of flow are all continuous and can be averaged and means compared over time. Changes in water flow can indicate over-pumping of groundwater from local aquifers, drainage of local wetlands, or variation in rainfall.

Data Analysis.

These data will be specific for each site and should, at first, be analyzed by comparisons over time at only that site. Between site comparisons might not be meaningful because of variation in wetland types and individual wetland conditions (e.g., catchment area). After several years of data are in hand, an analysis of between site variability can be used to assess whether individual measures are comparable to assess trends, or whether data within sites would need to be standardized (see chapter 12) in order to facilitate comparison between sites or types of sites.

Combined sites may be compared using non-parametric responses, such as a sign for the trend at an individual site, to capture information on the condition of wetlands as a whole.

8.6 Protocol 6 Open Water Biotic Sampling

Objective. Record the abundances of selected indicator taxa of animals in Illinois wetlands.

Rationale. Several aquatic invertebrates have been shown to be good indicators of water quality. The manuals by Mitchell and Stapp (1995) and Stapp and Mitchell (1995) provide detailed explanations of the rationales for which invertebrates are sensitive and which are more tolerant to water quality degradation.

The presence of pollution intolerant invertebrates at a site is one indicator of water quality. Presence of these organisms (seven taxonomic groups: dobsonfly larvae, caddisfly larvae, stonefly nymphs, gilled snails, riffle beetles, waterpenny, and mayfly nymphs) over time indicates that water quality is not decreasing. However, absence of pollution intolerant invertebrates may be due to poor sampling or otherwise inappropriate habitat. The presence of pollution tolerant invertebrates (aquatic earthworms, lunged snails, leeches, midge larvae, and blackfly larvae) in conjunction with an absence of intolerant invertebrates, likewise, could indicate degradation of water quality in the wetland.

Data Analysis. Mean numbers of each taxon can be compared by site over time, if reasonable frequencies are captured in samples. Owing to potential site differences in the capacity of differing wetland types to support various taxa, response variables must be tracked as standardized scores calculated for individual sites (see chapter 12). This will require several years of preliminary data prior to a state-wide summary of trends may be possible.

8.7 Protocol 7 Human Impacts

Objective. Observe visible signs of human impacts that affect wetland quality. Regularly recording this information on the level of human impact allows biologists to assess habitat in terms of human use.

Rationale. This segment primarily allows volunteers a unit to enhance their appreciation of how severely our natural habitats are impacted by human development. Nearly everywhere signs of human impact are visible within Illinois wetlands. From tree stumps previously cut, cats meandering through a meadow, to litter, signs of degradation are everywhere. This segment is also designed to enhance the volunteers appreciation of how to "read" the history of a wetland and current impacts by examining for signs of old trails, refuse, pets, standing dead trees (may indicate increases in water levels), etc.

Data Analysis. As in other EcoWatch units, we felt that monitoring direct human impact is a necessity, but began with few specific data analytic goals. We are not quite sure what kind of data will be submitted from this unit. We suggest creating data fields in the database to track these variables until a large database is available. Once many sites (e.g., >50) have been censused, one could try a variety of methods to analyze these variables. For example, Table 3.2 lists the attributes collected in ForestWatch Protocol 2.2f. We suggest using the same approach for wetlands. Each measure is given a +,-, or 0 to indicate whether it represents a good, bad, or neutral sign for wetland health. These values could either be summed to create a composite score fro good and bad signs of wetland quality and these sums could be analyzed for trends through time. Alternatively, standardized scores could be created for variables across a large number of sites. These standardized scores create a unitless value that should be equivalent across variables. Positive and negative attributes could then be summed to be analyzed through time as above. This latter method would be favored if there is a great discrepancy in the total quantity of various attributes. For example, if many more dogs are observed wandering through wetlands than cats, then any observed cat would add a mere blip to a site relative to the dogs. The observation of a single cat, however, may be a very important piece of information relative to observing dogs. Thus if the total observations of dogs and cats are standardized, then observing a high number of cats (e.g., 2) would count the same as observing lots of dogs (e.g., 5).

8.8 Protocol 8 Adult Dragonfly Census

Objective. Record the abundance of adult dragonflies in a wetland.

Rationale. Dragonflies are a common and easily observed insect in wetlands that have been used to indicate the quality of wetlands. Higher quality wetlands are expected to have increased diversity of dragonflies. Similarly, dragonfly diversity is expected to increase with improvement and decrease with degradation of wetlands. In this protocol we do not expect volunteers to be able to identify dragonflies to species. This requires capture and killing of individuals (and submitting voucher specimen, which may be necessary in the future). Rather we rely on volunteers to identify morpho-species based on color and patterns. A concern we have that can be addressed during the initial implementation phase is whether our identification aids are sufficient for accurate diversity assessments.

This protocol requires volunteers to collect two measures of dragonflies: diversity and density. Dragonfly density is collected by observing the number of dragonflies to fly over a 15 m suspended string. Dragonfly diversity is collected by observing the morphospecies observed within a 10 m radius.

Data Analysis. Density and diversity of dragonflies can be analyzed by comparing means over time, by sites. Interpretations are that decreased density or diversity are negative indicators of wetland quality. However, in interpreting these data, examination of the weather data is

necessary. Dragonflies are more likely to be in view on calm, sunny, warm days than on windy, cloudy or rainy, brisk days. Thus, weather is used as a covariate in the analysis.

8.9 Protocol 9 Frog Surveys

Objective. Record the abundances of frogs in Illinois wetlands.

Rationale. Amphibians are thought to be very sensitive to disturbance or pollution (REF). Trends in amphibian populations are currently being tracked all over the world in an effort to determine if there is a world-wide amphibian decline and whether this represents a biodiversity crisis (REF). By censusing frogs in Illinois wetlands, we can participate in this global effort. Frogs are a good monitoring subject because they can be monitored without capturing or killing them. Frogs call at predictable times of the years and their calls are species specific. Realize that these calls take some practice to recognize. As a result, this protocol is placed under the optional list of measures.

Data Analysis. Data collected in this protocol include the species and a code for the number of calls heard. For many sites interannual variability in sampling may swamp the trends in any individual site for any species (a low signal-to-noise ratio). Thus, summing all observations within a site may allow a trend analysis. Otherwise observations will need to be summed, and then divided by the number of sites sampled, for sites that share a characteristic over which the response will be evaluated (e.g., marsh versus open water sites). Further, the behavior of these organisms varies with weather (i.e., frogs need water for calling and a lack of recent rainfall may result in no standing water). Thus, we record weather information and the data analyst should use this as a covariate for analysis since most volunteers will not be able to choose to sample under a standard set of weather conditions.

8.10 Protocol 10 Fish Surveys

Objective. Capture and record fishes by species and frequencies.

Rationale. Fishes are good indicator species of wetland quality for wetlands where fishes might be expected. The best indicator of wetland quality will be fish diversity. Some species have very general habitat needs and can occur even in poor quality wetlands. Other species are more sensitive to water quality and will only be present in high quality wetlands.

Volunteers need to realize that an absence of fishes does not necessarily indicate a poor quality wetland. Fishes require some degree of open or standing water. Wetlands without open or standing water can not be sampled for fishes and should not be included in analyses. Owing to the expertise and additional equipment required for this protocol, we relegate this to the list of

optional sampling activities. Nonetheless, direct measures of diversity and abundance of key taxa of concern in wetlands are the best measure of trends in habitat, or ecosystem, quality with respect to those taxa. Fish represent one of these groups of concern.

Data Analysis. Species richness, the number of species collected can be analyzed over time, by site. However, species richness can be a function of collecting effort. Some standardization of collecting effort is necessary to make comparisons over time or between sites. Two generally accepted methods are to standardize by the number of seine hauls or by the amount of time seining. Again, inter-site variation is expected to be large. Thus, any regional summary or inter-site comparison should use standardized scores to capture the trends in observations at any single site and relate that to trends in a broader sense.

CHAPTER 9
POTENTIAL WETLANDWATCH ADDITIONS

9.1 Sediment loads, pollutant filtration and eutrophication

We have not fully explored the possibilities in terms of examining wetlands with respect to their function of removing sediment, nutrients and pollutants from surface waters. There is a very large literature in this area. Existing protocols examine some water quality measures, but focus primarily on biotic responses. The reason for this is that the Environmental Protection Agency is legally responsible for measuring compliance to water quality standards throughout the United States. These are not measures that need improvement. Instead, it is the biotic outcomes of habitat change are needed and are what was to be our focus in this project. Nonetheless, this is a relatively large area of interest in wetland ecosystems, and it may be useful to develop linkages in the degree to which a wetland exhibits chemical signs of eutrophication, or sustains pollutant loads and the biotic responses in our measures of habitat quality. We felt, however, that the suite of protocols that we present represent a workload that is sufficient for most school groups. Thus, we leave this for further evaluation after initial implementation

9.2 Shrub wetlands

The bulk of these protocols are designed for herbaceous dominated wetlands. Forested wetlands are explicitly excluded from consideration in this module. This leaves the problem of shrub-dominated wetlands. While these wetlands are less abundant than other types within Illinois (Suloway and Hubbell 1994). Nonetheless, comprising 4% of the states wetlands, scrub-shrub dominated systems are worth considering if this program becomes widespread in its application. The species lists presented, however, are not adequate for sampling these wetlands and would need to be revised specifically for this purpose. This relates to a broader issue of ecosystem complexity. It is possible to regionalize these protocols within Illinois and include a broader array of types in most modules (e.g., sand and hill prairies, bottomland forests). Careful consideration should be given, however, to the exponential increase in data management needs that will be created by increasing the variety of ecosystem types that are included in EcoWatch.

CHAPTER10
QUALITY CONTROL, DATABASES AND STATISTICS

10.1 Quality Control

We recommend the use of the Illinois Natural History Survey scientists to lead a team of 4 interns to validate measures from a subset of sampled habitats each year. These interns can rotate through the entire suite of sites such that each site within the program will be visited no less than once every 5 years. Sites with unacceptably high levels of disagreement between volunteer and intern samples will be extracted from the data set until further training and re-sampling reconciles the two samples. Targeting acceptable levels of variation will depend on the measure involved. habitat structure, habitat complexity, and plant health measures in ForestWatch related modules are taken on the very same vegetation. Thus, the only error should be in measurement error and values should not vary by more 5%. This 5% level is chosen somewhat arbitrarily and needs to be validated as a reasonable value by resampling a field site with interns to estimate error in data collected by the same individuals. These measures may also be checked in comparison to inter-annual variation within sites measured by the same teams once these data are available. Assuming no short term changes in forest condition (i.e., the first two years) we would expect measures to be the same. While this may be a weak assumption, measures such as forest structure, habitat complexity and tree health, we expect to change only slowly through time except in sites where active forest management results in structural changes. Non-native species density, disturbance-sensitive species density, animal densities and certain signs of human impact (e.g., number of people, cows, cats or dogs observed) may vary much more dramatically. Thus, variance in these measures between volunteer teams and interns is less interpretable. Since these repeat measures would be collected within the same year (although perhaps at different seasons), we expect the variation to be less than the mean inter-annual differences in measurements within sites. After 3 years of data collection EcoWatch coordinators may be able to calculate expected levels of variability between sampling intervals and set target levels for quality control alerts as a result of excessive variation between volunteer and intern sampling.

10.2 Database Format

For ease of data input within ForestWatch we have developed a Hypercard stack of the data sheets that will allow computer data entry by individual groups. The rationale for this step is that most high schools are keen on using computers and have Apple computers with Hypercard capabilities. Using the Hypercard stack, schools may create a computer database with their sites data. These data may then be archived within each school so that groups may be able to track

changes within their own sites. The data will also be submitted to a central database coordinator to allow a statewide analysis of EcoWatch response variables. Data submission modules on via Internet are also being discussed, but have not been developed.

Although not yet developed, we would like to see this database developed as a relational database in FoxPro so that fields may be used in a traditional spreadsheet analysis as well as retaining the ability to track text fields that include notes and site classification variables that may change through time.

10.3 Standardizing Response Variables

Frequently during the data analysis sections we refer to the problem that different measures are on inherently different scales. This scale problem would preclude unifying disparate scores into a unified response measure even if the two variables were measuring similar attributes of forest quality. A simple way to avoid this problem is to convert observations into standard scores (Zar 1984). This is accomplished by taking the aggregate of all observations of one variable and calculating the sample mean and standard deviation. Each observation is then subtracted from the mean and divided by the standard deviation (Equation 1).

$Z = (obs - \mu)/ \varsigma$ where: obs = observation
μ = sample mean
ς = sample standard deviation

The resulting distribution of standard scores has a mean of 0 and a standard deviation of 1. Standard scores can then be summed to give each variable equal weighting.

The value of giving each variable equal weight is that we have no *a priori* way of assigning different values to species unless we know that some species are better indicators of a particular attribute than other species. Given that we attempt to count species in groups (i.e., invasive non-natives, or disturbance-sensitive species) that are indicative of some measure of habitat quality, there is no real reason to suppose that one species is any better than others as an indicator. Similarly, if we were to try to characterize an overall impact of immediate human influence we might want to assess all categories of measured human influence (e.g., trash, trails, cats, dogs, traffic, etc) simultaneously. These are inherently different measures, however, so direct comparison is nonsensical. A standardized score provides the ability to make a unitless number that only reflects how extreme a measure is to others of its own kind. Thus, a site with consistently high or low values in individual categories would end up with a net score that is inordinately high or low, respectively.

10.4 Normality of Data

We assume a normal distribution of response variables, although this assumption is likely to be violated by some measures. Data transformations (such as log transformations) are encouraged to normalize data for analysis in trend detection. Proportional, or percentage data is discouraged, but where used must be transformed. A discussion of transformation rules is found in Zar (1984, Chapter 14). Nonparametric trend analysis is less sensitive to problems that arise from non-normal data distributions (Zar 1984).

10.5 Trend Analysis

There is a large literature related to the analysis of trends through time (e.g., NASA 1988, Loftis 1989). A good deal of this literature deals with sampling of pollutants for compliance with environmental monitoring standards (Loftis 1989). Much of this literature deals with one of two basic problems: detecting periodicity of cycles and unbalanced designs assessing before and after effects of some one time event (e.g., Underwood 1992, Glasby and Underwood 1996). Perhaps naively, we intend for EcoWatch response variables to be initially analyzed with the aim of discerning two simple measures: 1) the magnitude of variation between sites (and expected variance through time); and 2) a linear approximation of the slope of the trend through time. To accomplish the first goal simple parametric means and variances suffice. To accomplish the second goal, we will employ simple linear regression techniques, or their nonparametric counterparts, to detect significance through time. These methods may need to be updated, however, as concerns over the intricacies of particular responses to individual measures become apparent.

10.6 Primary and Secondary Response Variables

Some measures may, however, be better detectors of environmental change than others. Our procedures include measures that simply measure a suite of species that are of some interest and measurable (e.g., dragonflies) . There is no reason to believe that these species are a particularly sensitive measure of habitat change. In other cases (e.g., aquatic invertebrates, disturbance-sensitive species), we believe that the species do say something specific about broader concerns than simply diverisy of the counted taxa. Thus, we try an segregate variables into categories based on what we believe may be the generality of the response expressed by a specific response variable measured in a the EcoWatch protocols. Below is a table that includes all the response variables in ForestWatch as well as aggregate variables that may be tracked through the ForestWatch program. Table 10.1 provides a list of potential ways to subdivide the data set and compare sites within Illinois. This table provides a sufficient structure to do a similar table for the other EcoWatch modules.

Table 10.1. A list of primary and secondary response variables for ForestWatch habitat quality trend analysis.

Protocol	Primary Response Measures	Secondary Response Measures
1.1 Site Characterization	None	None
1.2 Establish transects	None	None
2.1 Forest structure	Aggregate of densities in each size class	Size class distributions by taxa (6)
2.2a Non-native species	Summed score of standardized density score for all taxa	Density by taxa (6)
2.2b Habitat complexity	Mean standardized score summed for duff, downed wood and understory vegetation complexity measures	Mean duff depth value Volume of dead wood Mean score for horizontal visibility at 0, 1, and 2 m
2.2c Animal life	Summed score of standardized density score for all taxa	Density by taxa (6)
2.2d Tree health	Mean foliage transparency for all taxa Mean crown density for all taxa Mean crown ration for all taxa Frequency of stem damage categories for all taxa Mean sapling vigor class for all taxa	Foliar transparency by taxa Crown density by taxa Crown ratio by taxa Frequency of stem damage by taxa Sapling vigor class by taxa
2.2e Disturbance-sensitive species	Summed score of standardized density score for all taxa	Density by taxa (6)
2.2f Human impacts	Standardized relative frequency of +/- observations	Relative Frequency of individual selected observations
3.1 Insect census	Relative insect density, by taxa	None
3.2 Leaf damage profiles	Rates of leaf damage, by taxa	None

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12. APPENDIX

The following is a sample letter to inform volunteer coordinators / teachers of the need to adhere to the protocol instructions, or opt to collect data that will not be included in the state-wide analysis.

Dear Teacher / Participant:

The EcoWatch program was developed within a framework of cooperation between scientists at the Illinois Natural History Survey, resource planners at the Department of Natural Resources, science educators and teachers. The explicit purpose of each of the EcoWatch units is to provide a means to accomplish two goals: environmental monitoring and environmental education. Through the Critical Trends Assessment Program we have established a need for a type of environmental monitoring, ecosystem monitoring, that is not met through other programs. EcoWatch is designed to meet that need. We believe, however, that increasing our understanding of human impacts on natural ecosystems will be meaningless unless we also educate our citizens as to the importance of these changes in our natural lands. Thus, we view the goal of providing a high quality environmental education opportunity as on par with the specific data collection objectives in EcoWatch.

Our explicit goal of EcoWatch is to create a database that will allow more informed discussion regarding natural habitats in Illinois. As such we maintain the highest possible standard EcoWatch data. We require complete compliance with the methodologies and standards outlined in the manuals. This includes everything from site selection down to how the data is entered on the data sheets. We can make no exceptions to this rule without suffering the consequence of a compromised data set. We request that you make every effort to follow the rules of the EcoWatch manuals.

We also recognize that there are locations and situations that preclude the implementation of the EcoWatch methodologies as stated in the manuals. Failure to find an appropriate site within your region, or failure to finish a particular protocol are problems with which we are often faced. We are forced to adhere to a strict policy in this regard. We encourage your participation in the program even if you must bend the rules laid out in EcoWatch. Please be aware, however, that under such circumstances your site may not be used within the database. Participants who, for example, use non-qualified sites do so at the risk of not having their data included in the analyses. Therefore the value of your participation in EcoWatch falls under the rubric of environmental education in situations where the data will not be used. The EcoWatch protocols represent a high quality environmental education experience for students, and for this alone they are worth the effort. The EcoWatch program will do everything it can to help you use EcoWatch in whatever way you can. In addition, data gathered from unregistered sites may be informally compared to database results in order to put your particular site into a regional perspective.

Sincerely,

EcoWatch Project Coordinator
Critical Trends Assessment Program
Illinois Department of Natural Resources